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Complete Program and Abstracts of Papers in this Issue

INSTITUTE OF FOOD TECHNOLOGISTS

FOOD TECHNOLOGY

PUBLISHED BY THE INSTITUTE OF FOOD TECHNOLOGISTS

IN THIS ISSUE

The Use of Antioxidants in Dry Dog Food

A New Method for Measuring the Development of Rancidity

Military Subsistence Requirements Reflect Circumstances of Use

Influence of Processing Variables on Drying Rate and Quality of Dehydrated Frozen Sweet Corn

A Method of Determination of Rehydration Rate of Dehydrated Sweet Corn

Does Pepper Contribute to Food Preference?

Effect of Freezing and Freezer Storage Upon Quality of Baked Rolls, Brown-and-Serve Rolls, and Shaped Roll Dough

Viability of Thermophilic Bacteria in the Presence of Varying Concentrations of Acids, Sodium Chloride and Sugars

Effects of a Meat Tenderizer on Less Tender Cuts of Beef Cooked by Four Methods

Affairs of the Institute

May, 1953 Pages 189-220 Volume 7, Number 5

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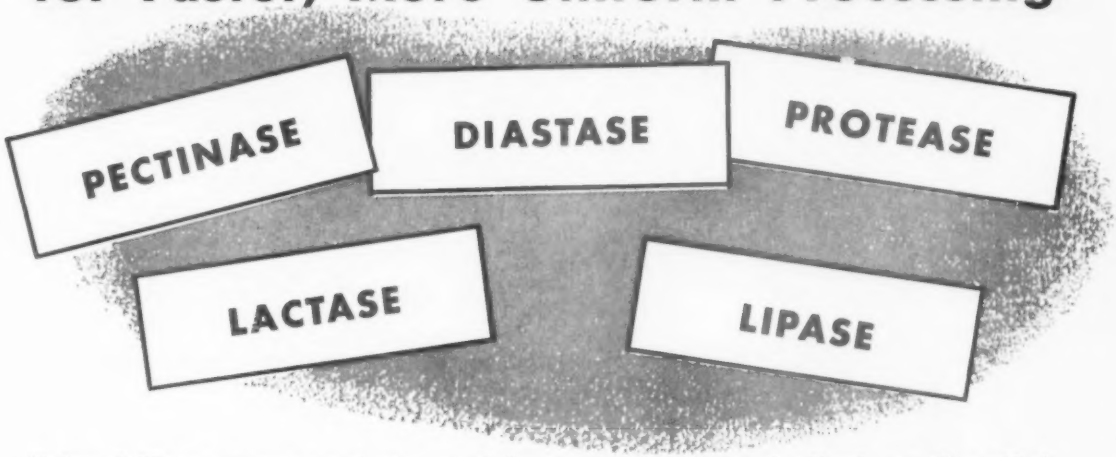

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Published Monthly by the Institute of Food Technologists

Volume 7 **May 1953** **Number 5**

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Responsibility for statements appearing in FOOD TECHNOLOGY rests on the author thereof; points of view expressed in the columns of the journal do not necessarily have the indorsement of the Institute of Food Technologists.

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176 West Adams Street, Chicago 3

Address to the business office all requests for subscriptions, changes of address, and information on advertising. Claims for copies lost in the mails must be received 30 days after issue (90 days, foreign). Changes of address must be received at least two weeks before date of issue.

Subscription Rates: For members the cost of subscription is included in the annual dues. Non-members: domestic, $7.50 per year; foreign, $8.50 per year. Single and back copies: domestic, $1.00; foreign, $1.15.

Advertising Representatives: *Eastern:* Duncan Macpherson, 700 S. Washington Square, Philadelphia 6, Pa. *Midwestern:* Prendergast and Minahan, 168 N. Michigan Avenue, Chicago 1. *West Coast:* Duana Wanamaker, 610 S. Broadway, Los Angeles 14, California.

Publication Office

The Garrard Press, 119 West Park Avenue, Champaign, Illinois

Address to the Publication Office all requests for non-member subscriptions, back volumes, single copies (costs are listed above). Authors desiring reprints should address orders to this office; rates are printed on the order blank. (Requests for a single reprint of a published paper should be addressed to the author.)

FOOD TECHNOLOGY is published by the Institute of Food Technologists and printed by the Garrard Press, Champaign, Illinois, U. S. A.

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Mailing Permit: Entered as second-class matter, Feb. 25, 1947, at the Post Office at Champaign, Illinois, under the Act of August 24, 1912.

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Affairs of the Institute

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Food World News

VICTOR CONQUEST
1953 Appert Award Winner

Winner of the Appert Medal for 1953 is Mr. Victor Conquest, vice president in charge of research and development, Armour and Company. Mr. Conquest will receive the honor at the Annual Meeting of the Institute of Food Technologists to be held in Boston during the week of June 21. The Award Committee has been at work over the past several months, and George Brissey, chairman of the Institute's Chicago Section, made the announcement concerning this happy choice on May 1, 1953.

Victor Conquest

Nineteen fifty-three Appert Medalist

Fabian Bachrach

For the benefit of newer IFT members it should be mentioned that the Appert Medal signalizes outstanding achievement in food technology and is awarded annually by the Chicago Section to a food technologist who has fostered the improvement of foods—or made possible the development of new foods—through research or better production methods. Mr. Conquest has devoted his entire career to such improvements—10 years as a production control technologist and 27 years as an administrator inspiring others to develop tastier and more nutritious foods.

As head of Armour's research program, Victor Conquest has guided a number of significant developments, among them the production of improved dehydrated eggs. Behind this particular achievement is the story of a man who listened to the gripes of servicemen of World War II about dried eggs and then inspired his staff to go out and develop a product "that they can't tell from fresh eggs." The production of sugar-free eggs was guided by the Appert Medal winner and the product itself—known as egg solids—has grown to the stature where it is as readily accepted as perishable fresh or frozen eggs.

Biographical Highlights

Victor Conquest was born on a farm near Kansas City, Kansas, and attended grade and high schools in that state. He received his academic training and was graduated from the University of Kansas, his field of specialization being chemical engineering and bacteriology. While serving in the U. S. Army in France in World War I he had an opportunity to extend his studies, having been transferred to the Central Medical Department Laboratory of the Chief Surgeon's Office for advanced work. Here he became acquainted with scientists busy with perplexing biochemical problems, among them certain, not then recognized, nutrient factors, which appeared to be present in some foods and not in others. These factors, of wide interest in the science of that time, later became identified as vitamins and the literature, of course, has been filled with studies on or related to these nutrients ever since. After World War I, Mr. Conquest entered upon his professional career; over the years he has been identified with research on animal products and by-products with Morris and Company, with Wilson and Company, Kansas City branch, and with Armour and Company, Chicago, his present affiliation. He organized the first central research department for Armour and Company in 1929 with 15 persons employed. More than 500 persons are now engaged in Armour's extensive research activities.

Mr. Conquest has travelled widely in South America and elsewhere on professional missions. He has published extensively on food preservation, food chemistry, and the technology of meats. Active in the professional societies, he is a member of the National Egg Products Association, the American Meat Institute, and has held office from time to time in the American Chemical Society, the American Oil Chemists Society, and in our own society, the Institute of Food Technologists.

In the Laboratory

Selection of Mr. Conquest as the newest Appert Award winner recalls to mind that the 200th anniversary of the famous pioneer in food technology, Nicholas Appert, was observed in 1952. The trail blazed by this pioneer food technologist is now a highway well marked with achievements, many of which have been made by Dr. Samuel Cate Prescott, the winner of this year's first

Annual Citation, by the succession of Appert medalists, by the Babcock Award winners, and, of course, by others as yet unnamed. The Institute of Food Technologists can pride itself on its program of achievement awards and on the calibre of its most recent as well as all of its preceding awardees.

Regional Section News

CHICAGO SECTION

Dr. W. M. Martin, Vice President of the James Dole Engineering Company, spoke on "Aseptic Canning Process Embodying Short High-Temperature Sterilization of Foods" at the March 9 meeting of the Chicago Section to an overflowing crowd of 126 members. He discussed the history of the process, using graphs and slides, and told of his future plans to provide completely automatic controls. Cans of cream style corn were cut and comments of the members were encouraged.

NORTHEAST SECTION

The Section's annual Spring meeting was held on April 2, 1953, when Messrs. Robert and Walter Friend of Friend Brothers, Inc. invited the Section to be their guests for the evening. They arranged with their neighbors, Continental Can Company, to have a can line running so that everyone could see the operation of that plant, and later inspect Friend Brothers' operation for preparing and cooking their well known baked beans. Because of the time of day, the actual preparation rooms could not be seen in operation but they were open for inspection. The baking operation, however, was in progress for the members to see. Dinner was served in the commissary of the Friend Brothers' plant, compliments of the firm. Dr. Donald K. Tressler, Director, Quartermaster Food & Container Institute, Chicago, was the guest speaker and his topic was "Food Problems of Special Concern to the Armed Forces."

MARYLAND SECTION

The March meeting of the Section was held at the Stafford Hotel on Friday, March 13th. Mr. E. N. Funkhouser, manager of the CRYOVAC Division of the Dewey & Almy Chemical Co., spoke on Meat Merchandising using CRYOVAC wrappings. Mr. Funkhouser stated that the entire method of merchandising meats had changed since 80% of the entire production was being sold in super markets. He pointed out that self-service in these markets had made mandatory the use of mass displays with eye-appeal to stimulate impulse buying. He showed that producers were able to extend the shelf life, to protect the quality and maintain packing weights with the rugged package which they have developed.

A film titled "The Second Skin" gave a visual demonstration of the place that CRYOVAC is now occupying in food distribution."

DIXIE SECTION

On Friday, April 3rd, 1953, the Section assembled in the lobby of the Woodruff Memorial Building at 5:00 P.M. This building is Emory's newest and largest and houses laboratories for medical research.

Mr. R. F. Whitaker, Associate Director of Development, discussed Emory's place in the field of medicine and health and its relation to the field of study of our group. Faculty members of the School of Medicine described the types of research being done. A tour through the laboratories, library, and other facilities of the building, followed. Dinner was served at 6:30 P.M. in the Alumni Memorial Building.

The after dinner program was given by the Federal Civilian Defense Administration for the Southeastern Region. The role of food technologists in Civilian Defense was discussed by Mr. Dial F. Sweeny, Regional Supply Officer, who spoke on: "Sources and Distribution of Foodstuffs in Case of National Emergency," and by Dr. John M. Whitney, Regional Medical Officer. "Coordination of the Food Technologists with the Civilian Defense Program" was the topic of the last-mentioned speaker.

OREGON SECTION

The Section met in the evening of February 11, 1953, at the Memorial Union Building on the Oregon State College campus.

The program, featuring talks by staff members from various departments on the O. S. C. campus, was as follows:

"New Emphasis on Milk Proteins," G. A. Richardson, Dairy Department, O. S. C.

"The Use of Mosquitoes in an Analytical Lab," L. C. Terriere, Agricultural Chemistry Dept., O. S. C.

"Dehydration of Green Beans," L. A. Pettit, Food Technology Dept., O. S. C.

"Modern Analytical Tools," H. D. Reese, Chemistry Department, O. S. C.

GREAT LAKES SECTION

The Section held its Annual Meeting, Friday, April 17, 1953, at Kellogg Center, Michigan State College, East Lansing, Mich. In the morning a tour was made of Dr. F. W. Fabian's new laboratories at 172 Giltner Hall, and the Food Research Laboratories at 110 Home Economics Bldg.

The afternoon was devoted to a series of short talks outlining the current research in food technology at Michigan State College. The talks were as follows:

"Relation of Soil Fertility to Nutritive Value of Crops," L. M. Turk, Soil Science Dept.

"Some Characteristics of the Fat Globule Membrane Proteins," J. R. Brunner, Dairy Dept.

"Processing of Michigan Fruits," C. L. Bedford, Horticulture Dept.

(Continued on page 8)

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Regional Section News

(Continued from page 6)

"Weight Reduction through Diet," M. A. Ohlson, Foods and Nutrition Dept.

"Spectrophotometric Measurement of Color Changes in Prepackaged Fresh Meats," O. D. Butler, Animal Husbandry Dept.

"Flat-sour Spoilage of Tomato Products," L. S. White, Bacteriology Dept.

"Nutrition of Vinegar Bacteria," R. C. Zalkan, Bacteriology Dept.

"New Aspects of the Food Research Program at M.S.C.," E. Osman, Foods and Nutrition Dept.

J. G. Hays, Dairy Dept., M.S.C., was the after-dinner speaker. His topic was "Architectura Bovidae Taurine Typicus Prima Genus et Longifrans." (To learn the translation, you had to be there to find out.)

PERSONNEL

By action of the executive committee of the Council a new panel of nominees for Associate Editorships on *Food Research* was approved in January. Newly appointed editors are: Dr. J. Grant Armstrong, Chief of the Food Section, Defence Research Medical Laboratory, Department of National Defence, Toronto; Dr. Kenneth W. Brighton, Associate Director of Research, American Can Company, Chicago; Dr. John R. Matchett, Assistant Chief, Bureau of Agricultural and Industrial Chemistry, Agricultural Research Administration, U. S. Department of Agriculture, Washington, D. C.; and Dr. Robert G. Tischer, formerly professor at Iowa State College (Food Processing Laboratory), Ames, Iowa, and presently Director of Food Laboratories, Quartermaster Food and Container Institute for the Armed Forces, Chicago. The new editors have already contributed review and other services to *Food Research*. They bring to the elder journal of the society a rich experience in writing and publishing and their scientific backgrounds are sufficiently divergent to assure a continuation of the broad editorial interests which have always been characteristic of the editorial boards of our IFT journals.

Wolfgang Huber, formerly Group Leader in Organic Chemistry, Sterling Winthrop Research Institute, and since 1945 Director of Chemical and Biological Research, Electronized Chemicals Corporation, has resigned as Vice President of the Corporation to enter practice as a management and research consultant. His work during the last seven years has been concerned chiefly with studies of the effects of ionizing radiations on biological and chemical systems, with particular reference to food and drug preservation. Dr. Huber recently organized a symposium on ionizing radiation at the Polytechnic Institute of Brooklyn.

Dr. Harry E. Goresline, chief, Stability Division, Quartermaster Food and Container Institute, has been awarded the Production and Marketing Administration Certificate of Merit "for his outstanding leadership and extraordinary contributions in the development of (1) commercial methods to eliminate dangerous salmonella bacteria from processed eggs and egg products; and (2) improved sanitizing methods for use in processing plants to improve the sanitary quality of poultry."

Books

Food-Borne Infections and Intoxications by Fred W. Tanner, Ph.D., D.Sc., formerly Professor of Bacteriology and Head of the Department, University of Illinois, and Louise P. Tanner, Ph.D., formerly Associate in Home Economics, University of Illinois, Second edition, Cloth $12.00, pp. 769. The Garrard Press, Champaign, Illinois.

This book is composed of 16 chapters dealing with sanitation problems, food borne diseases and food poisoning caused by bacterial toxins and by metals. The book was designed to supplement the discussions in the author's Microbiology of Foods published in March 1944. A comprehensive review of the literature is made and outbreaks of illnesses are selected to illustrate the effects of the agents under discussion. Issues are presented by the authors such as in the preface "Heat stable gastro-intestinal irritants formed by Salmonella and Staphylococcus now furnish a much better explanation of illness caused by foods than the old diagnosis of ptomaine poisoning." The preponderance of evidence both experimental and epidemiological indicate that man is not made ill by eating heat stable products of Salmonella. Furthermore, the mode of action of either Salmonella or Staphylococcus enterotoxin in causing illness in man has not been demonstrated to be a gastro-intestinal irritant. The book may be recommended for its valuable coverage of the literature.

G. M. Dack.

Selected Abstracts*

ANALYTICAL METHODS

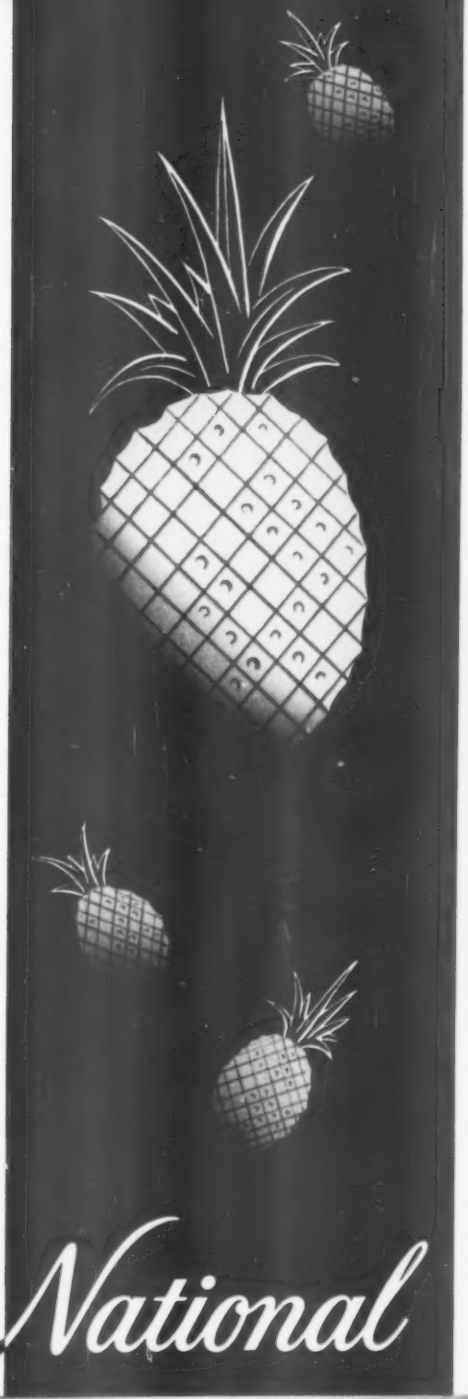
Gas-liquid partition chromatography: the separation of volatile aliphatic amines and of the homologues of pyridine.

James, A. T. *Biochem. J., 52,* 242-7 (1952).

The sepn. and micro-estn. of a series of aliphatic primary, secondary and tertiary amines is described. A straight-line relationship is obtained when the logarithms of the retention volumes are plotted against the number of carbon atoms for each type of primary, secondary and tertiary amine. By means of this relationship the relative retention volume of any amine may be predicted provided the retention volume of any other member in the correct homologous series is known. The utilization of columns having polar and non-polar liquid phases to det. whether an unknown amine is primary, secondary or tertiary is described. A plot of the relative retention volumes of primary, secondary and tertiary amines on paraffin against those obtained with "Lubrol MO" liquid phases shows the values for each type of amine to fall on straight lines of different slope. Out of 27 amines contg. from 1 to 12 carbon atoms only two pairs (*iso*- and *sec.*-butyl-amine; di*iso*- and di-*sec.*-butylamine) cannot be

* These Selected Abstracts are made available to Food Technology through the cooperation of Associate Editor H. A. Campbell and the General Foods Corporation of New York, N. Y. The abbreviations found in these abstracts are similar to those used by Chemical Abstracts.

(Continued on page 10)



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Abstracts

(Continued from page 8)

sepd. on 4 ft. columns. The sepn. of the homologues of pyridine is described as a suitable method for the approx. standardization of pyridine bases for chromatographic use.

Rapid procedures for the determination of cobalt in plant material.

JENSEN, E. *Anal. Chim. Acta., 7,* 561-6 (1952).

Selective adsorption on a small column of active alumina is utilized in a procedure for the colorimetric detn. of cobalt in plant material, using nitroso-R-salt as the coloring agent. The method uses only simple app. and is very time-saving. The accuracy is ± 3 or 4 mg. cobalt per ton of dried plant sample.

A simple paper electrophoresis apparatus.

CONSDEN, R., AND STANIER, W. M. *Nature, 170,* 1069-70 (1952).

A simple paper electrophoresis app. capable of giving highly reproducible results is described. The value of the method is increased greatly by the use of chromatography at right angles to the electrophoretically sepd. proteins.

The determination of the carboxylic groups in proteins. II. The terminal carboxylic group of ovomucoid.

PENASSE, L. *Biochim. et Biophys. Acta., 9,* 551-6 (1952).

It appears that ovomucoid contains only a single free carboxylic end group, namely a group belonging to phenylalanine.

o-Phenylenediamine and 1:2- diamino-4-nitrobenzene as reagents for α-keto acids.

HOCKENHULL, D. J. D., AND FLOODGATE, G. D. *Biochem. J., 52,* 38-40 (1952).

A series of stable nitroquinoxalinols, new colored derivs. of α-keto acids, has been prepd. The quinoxalinols obtained by condensation of either *o*-phenylenediamine or 1:2-diamino-4-nitrobenzene with pyruvic, dimethylpyruvic and α-ketoglutaric acids, may be sepd. by paper chromatography. The nitroquinoxalinols may also be sepd. on alumina. 1:2-Diamino-4-nitrobenzene is superior to 2:4-dinitrophenylhydrazine as a reagent for α-keto acids, in specificity, stability, separability and characterizability of the products.

BIOLOGICAL SCIENCES

BIOCHEMISTRY

The biosynthesis of protein. I. Uptake of glycine, serine, valine, and lysine by the mammary gland of the rabbit.

CAMPBELL, P. N., AND WORK, T. S. *Biochem. J., 52,* 217-28 (1952).

Lactating rabbits were injected with C^{14} glycine, valine or lysine. Time activity curves indicated that the radioactive milk protein was derived from radioactive blood amino acids. A very small portion of the milk proteins was derived from radioactive plasma protein. Much of the glycine was transformed to serine in the milk protein. The authors postulate that protein synthesis in the mammary gland involves simultaneous utilization of free amino-acids from the blood and peptides derived directly or indirectly from blood proteins. A method for the quant. estn. of glycine in small samples of proteins is given.

Metabolism and urinary excretion of several flavonoid compounds.

HALEY, T. J., AND BASSIN, M. *Proc. Soc. Biol. Exptl. Med., 81,* 298-300 (1952).

A study has been made of the metabolism and urinary excretion of rutin, hesperidin, hesperidin methyl chalcone, naringin and phloroacetophenone. Whereas the latter compd. is to a large extent excreted either free or combined, the flavonoids, with the exception of rutin, are probably destroyed in the body or converted into other compds. which were not detected by the methods used. Rutin is partially destroyed in the body and partially handled by the usual phenol excretion pathways of sulfate and glucuronide.

Review: On the regulation of blood cholesterol.

BYERS, S. O., FRIEDMAN, M., AND ROSEMAN, R. H. *Metabolism, 1,* 479-503 (1952).

The normal plasma cholesterol content appears to be chiefly regulated by the liver, which manufactures and discharges cholesterol into plasma, then later removes and destroys or converts it into cholic acid (cholate) and perhaps other substances. Variations in the absorption or excretion of cholesterol at most have only a moderate influence on the plasma cholesterol level in most mammals. Marked changes in plasma cholesterol, therefore, are usually due to alterations in either the rate of synthesis or destruction of cholesterol.

Experimental hepatic injury.

GYORGY, P. *Am. J. Digest. Diseases, 19,* 392-6 (1952).

Aureomycin has beneficial effect on prevention of exptl. hepatic necrosis in rats. Author relates benefit of anti-microbical agents on growth and prevention of cirrhosis to sparing effect on essential constituents of food ingested.

Stability of vitamin B_{12} activity in liver injection.

STAPERT, E. M., FERRER, E. B., AND STUBBERFIELD, L. *J. Am. Pharm. Assoc., 61,* 587-9 (1952).

An investigation was made to det. the stability of vitamin B_{12} activity in liver injection prepns. The effects of exposure to air, oxygen, and light were investigated. Stability studies were made at temps. of 5, 24, 40 and 47°. Deterioration demonstrated by microbiol. assays was confirmed by chem. assay.

Antidotal efficacy of vitamin B_{12a} (hydroxo-cobalamin) in experimental cyanide poisoning.

MUSHETT, C. W. *Proc. Soc. Exptl. Biol. Med., 81,* 234-7 (1952).

Vitamin B_{12a} (hydroxo-cobalamin), but not vitamin B_{12} (cyano-cobalamin), has been found to be capable of preventing in mice the toxic symptoms and death due to cyanide administration. When injected into mice exhibiting complete respiratory arrest and coma due to cyanide poisoning, vitamin B_{12a} effected rapid recovery of most animals. In mice injected with potassium cyanide followed by vitamin B_{12a}, some of the cyanide appears in the urine as thiocyanate, but a greater percentage of the cyanide appears as vitamin B_{12}, having formed this compd. by reacting with the vitamin B_{12a}.

A substance in animal tissues which stimulates ketone-body excretion.

STEWART, H. B., AND YOUNG, F. G. *Nature, 170,* 976-7 (1952).

A factor in horse meat responsible for the increased ketonuria of rats has been concd. from the mono-amino phosphatide fraction of horse muscle. Elemental analysis showed the presence of only C, H and O. The structure appears to be that of a ketone. Normal, as well as diabetic animals on high fat diet, were made to excrete increased quantities of ketone bodies when given the factor by mouth or stomach tube. The ketone body factor was not found in casein.

The occurrence of lymphocytes with bilobed nuclei in cyclotron personnel.

INGRAM, M. *Science, 116,* 706-08 (1952).

The increased occurrence of binucleate lymphocytes appears to be related to exposure to exceptionally small amts. of radiation. Since lymphocytes may readily be obtained for examn. it is suggested that the presence of these cells may serve as a practicable and sensitive adjunct to phys. monitoring when personnel are subject to ionizing radiation.

The reactivity of radiomimetic compounds. 1. Cross-linking of proteins.

ALEXANDER, P. *Biochem. J., 52,* 177-84 (1952).

Nitrogen mustards, bisepoxides and tris (ethyleneimino) triazine, all radiomimetic compds. cross linked serum albumin in a 2% albumin soln. Similar results were obtained in most cases for wool fibers. The reaction occurred between pH 4 and with an optimum of pH 7. Acetylation of wool prevented cross linking but esterification caused no inhibition of cross linking. The cross-linking tests did not differentiate between biologically active and inactive compds.

(Continued on page 12)

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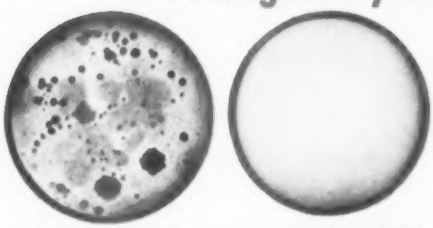

Petri dish showing colonies of bacteria before the use of ROCCAL.

Petri dish showing no bacterial growth after the use of ROCCAL.

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Abstracts

(Continued from page 10)

A flame photometer for routine biochemical use.

WARREN, R. L. *J. Scientific Instruments, 29,* 284-6, September, 1952; *Battelle Tech. Rev., 1,* 802a, November-December, 1952.

Describes construction, operation, and performance of an instrument designed primarily for detn. of Na and K. Sample is atomized with compressed oxygen and sprayed directly into an oxygen-butane flame.

NUTRITION

Antibiotics for the starving.

Science News Letter, 62, 275 (1952).

Because antibiotics have a protein-sparing action, their addn. to diets contg. little protein would increase the nourishing, value of such diets. These conclusions were based on animal tests in which rats were fed a rice diet. The rats fed rice supplemented with vitamins, minerals and small amts. of threonine and lysine did almost as well as animals fed a stock colony diet, when penicillin or aureomycin was included in the diet. This finding would be significant in the feeding of the starving people of Asia.

Intermediates formed during the digestion of triglycerides.

MATTSON, F. H. *J. Nutrition, 48,* 335-44 (1952).

Lipids recovered from the lumen of the intestines of rats following the feeding of triglycerides were analyzed for monoglyceride by periodic acid before and after isomerization with perchloric acid (this causes a conversion of 2-monoglyceride to 1-monoglyceride), for free fatty acid, and for hydroxyl value. The lipids were also fractionated by the Craig separator and the presence of monoglycerides confirmed by x-ray diffraction patterns and infrared adsorption. Appreciable quantities of monoglyceride and diglyceride are formed and accumulate in the lumen of the intestinal tract during the digestion of fat. These glycerides constituted as much as 16 and 36%, resp. of the total lipids. A portion of the monoglyceride found was of the 2- configuration, and the data indicate that almost all of the monoglycerides formed were initially the 2-isomer. It is likely that the diglycerides formed are of the 1, 2-configuration.

Administration of fat emulsion by mouth, gastrostomy and jejunostomy.

GOLDBERG, E. M., STEIN, I. F., AND MEYER, K. A. *J. Am. Med. Assoc., 150,* 1665-7 (1952).

A high caloric feeding consisting of a 40% fat emulsion, supplemented by protein concentrate, minerals and vitamins, was administered to 90 patients. Administration of 400 g. of fat per day in the upper gastrointestinal tract is usually tolerated and is almost completely absorbed. A marked increase in wt. occurred in patients with benign obstructing disease of the upper gastrointestinal tract and with malignancy of the mouth, however, little improvement was evident in patients with far advanced malignant disease. Mild symptoms of nausea, vomiting, diarrhea, or constipation occurred in approx. 50% of the cases.

Influence of carboxymethylcellulose on digestion in human subjects, rats and rabbits: its properties and possible uses.

ZIEGELMAYER, W. *Arch-Tierernahr, 2,* 33-52 (1951); *Brit. Abstracts, B III,* 568 (1952).

Carboxymethylcellulose (com. Na salt) is excreted quantitatively by human subjects and rats, but is assimilated to an av. extent of ~ 50% by rabbits. It has no harmful effects, does not inhibit the growth of young rats, and acts as a transporting and emulsifying agent. In rats and human subjects, the protein and fat digestion coeff. are somewhat decreased in its presence, but in rabbits the protein coeff. is unaltered, while the fat coeff. is increased by 9%. Carboxymethylcellulose is detd. in cold aq. exts. from faeces by the coloration given with 1-naphthol and H_2SO_4. Spectrophotometric calibration curves are given.

Daily iron ration needs increasing.

Science News Letter, 62, 325 (1952).

Studies with radioactive iron show that only 10% or less of the iron in foods is actually absorbed. The foods studied were those which could most easily be produced or grown so as to contain the radioactive iron: eggs, chicken and rabbit liver, chicken muscle, mustard greens and spinach. Vitamin C aids in the absorption of iron from food. The present recommended ration of 12-15 mg. per day is "none too high."

Vitamin and other nutrients in adaptation to stress.

GOODHART, R. S., AND JOLLIFFEE, N. *Merck Reporter, 61,* 7-10, October, 1952.

Ascorbic acid found in high concn. in the adrenal glands is needed in addnl. amts. in adaptation to stresses such as cold or low oxygen tensions. Requirements for the B vitamins also rise during stress, for example pantothenic acid, vitamin B_6, takes part in antibody synthesis.

ENGINEERING

Bibliography of drying. I-III.

BICKLE, W. H. *Dept. Sci. Industr. Res.,* 1-288, 289-519, 520-802, + 35 pp. (1951); *Brit. Abstracts, B I,* 1521 (1952).

A comprehensive bibliography, with short abstracts of the papers listed, is presented under the headings (no. of references in parentheses): general principles (781), drying processes and equipment (949), agriculture (465), food (694) and industrial materials, including, e.g., timbering, ceramics, metallurgy, coal, textiles, etc. (1750). An appendix gives the list of sources referred to.

FOOD AND FOOD TECHNOLOGY

Greasing eliminated in baking pans using non-sticking finish.

Agric. News Letter, 21, 8, January-February, 1953.

"Teflon" polytetrafluoroethylene finish is being tested as a coating on bread baking pans because the pans require no greasing before each bake. Elsewhere in bakeries where dusting with flour has been required to prevent dough from sticking, "Teflon" has solved the problem and increased output in doing so. Engineers, particularly in the packaging industry or wherever adhesives are used, have long been occupied with the problems of glue sticking to machine parts preventing accurate and efficient operations. A similar problem exists where sticky substances such as powdered soap, rubber, candy, and frozen foods are apt to cling to the smoothest metal surfaces. The finish is a water suspension of a Du Pont-invented plastic which has such a high chem., heat, and moisture resistance that it is also used to prevent corrosion of equipment and as electrical wire insulation. It is an expensive material to produce and will probably never reach a price level that would qualify it as a consumer product. Moreover, the finish must be fused at about 750° F. in special equipment. Consumers may benefit in scores of possible applications now under study such as muffin pans, funnels, rolling pins and measuring cups. Heat sealers for freezer packages coated with "Teflon" have already been introduced.

Changes in taste of oat products on storage, and their modification.

HEISS, R. *Dtsch. Lebensmitt. Rdsch., 48,* 129-33 (1952); *Brit. Abstracts, B III,* 638 (1952).

Development of bitter taste in oats is assocd. with peroxide val. > 2 per g. of dry solids, by Purr's method. When rolled oats were heated under controlled conditions in a closed annular space, 4 mm. wide, between two concentric cylinders (diameter of inner cylinder 90 mm.), the times of heating for reduction to the above value were reduced with rising temp. (85-125°) and increased with increasing moisture content (5-25%) in the oats. The reaction velocity quotient for the reduction of the peroxide val. increased from ~ 2 for the range 125-115° (with 8% of moisture) to ~ 360 for the range 95-85° (with 14.5% of moisture). The taste of the oats deteriorated at the higher temp. The requisite times of heating varied with different varieties of oats.

The occurrence of trimethylamine and trimethylamine oxide in fresh water fishes.

ANDERSON, D. W., AND FELLERS, C. R. *Food Res., 7,* 471-4 (1952).

Small mouth bass, pickerel, white perch, yellow perch, black crappie, sunfish, blue gills, Eastern golden shiners, and bull-

(Continued on page 14)

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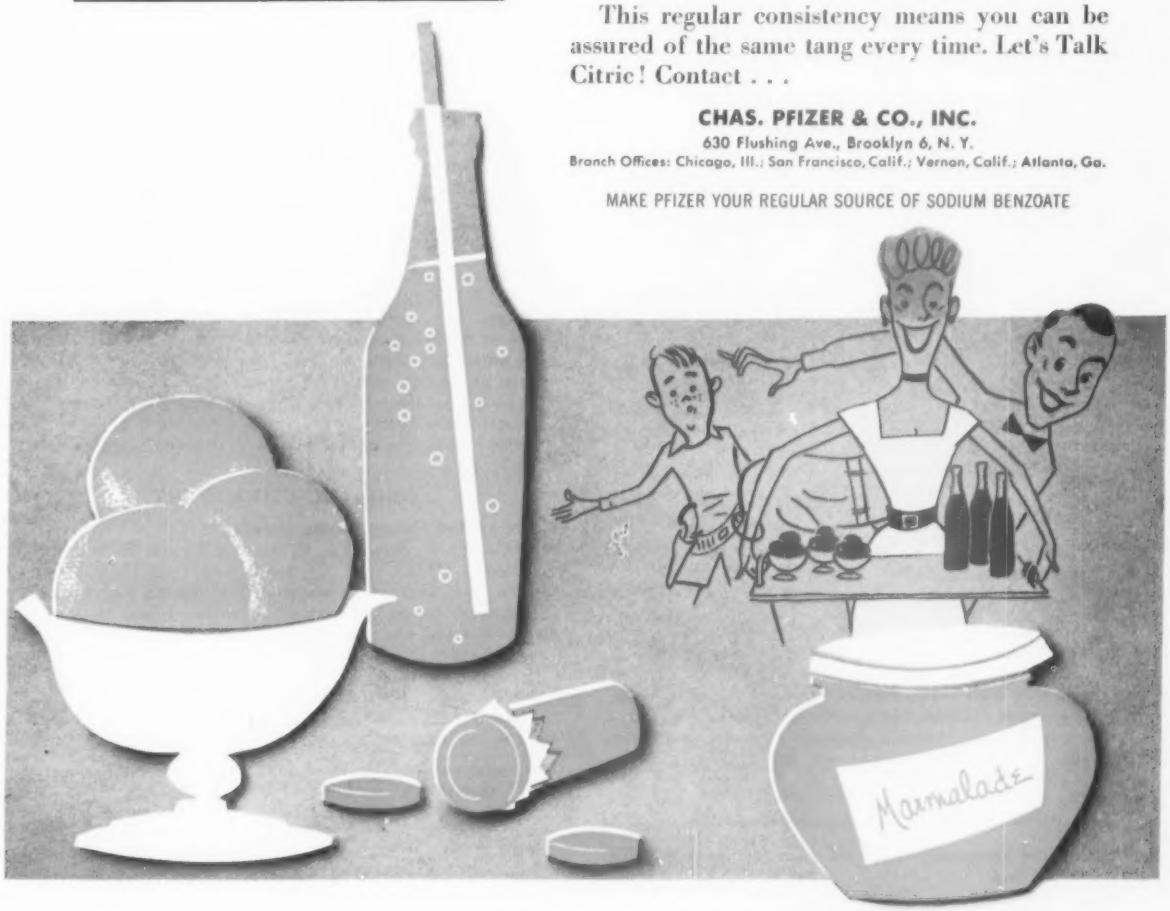

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Abstracts

(Continued from page 12)

heads, were analyzed for trimethylamine oxide and trimethylamine. All species were found to contain small amts. of trimethylamine. The small mouth bass, pickerel, white perch, black crappie, sunfish, and blue gill were found to contain trimethylamine oxide. These amts. were small in comparison to marine fish. The trimethylamine oxide content of hatchery raised brown trout, fed a diet contg. trimethylamine oxide from herring, increased with age of fish, and appeared to be of exogenous origin. On the other hand, trimethylamine in the other fresh water fish apparently originated in the muscle trimethylamine oxide.

Freezing fish at sea—New England. Part V—Freezing and thawing studies and suggestions for commercial equipment.

Comm. Fisheries Rev., 14, 8-23, December, 1952.

Data are presented on pilot-plant studies of factors effecting the (1) rate of freezing whole round fish in refrigerated sodium-chloride brine and (2) the rate of thawing frozen fish in fresh water. Recommendations are made for the design and operation of commercial-size equipment for freezing fish aboard a vessel and for thawing them ashore.

The Chayen cold-rendering process for oils and fats.

Soap, Perfumery Cosmetics, 25, 1263-4 (1952).

A revolutionary process for extg. oils and fats from naturally occurring cellular material, a development of British Glues and Chemicals, Ltd. Described as impulse rendering, the material to be rendered is suspended in a stream of water and the mixt. subjected to a series of high-frequency mechanical impulses. Action likened to hydraulic drilling opens cells and tears away cell contents. In com. production for degreasing bones, producing high-grade fat, no heat is involved, and the process takes only minutes. Sharples Corp. has been made U. S. agent for the process.

Surface activity of naturally occurring emulsifiers.

Dasher, G. F. *Science, 116,* 660-3 (1952).

A study is made of the boundary tension relationship in systems resembling those appearing during the digestion of fats, and the effect of monoglycerides, bile salts, and fatty acids on oil-water boundary tensions in such systems. Bile salts are shown to be the most effective surfactants in a system simulating digesting fat. Fatty acids are also effective, while monoglycerides seem to have no effect on the oil-water boundary tension in such a system.

A simple method for the improvement of the keeping quality of oils and fats.

Bertram, S. H., and Wynia, G. M. *J. Am. Oil Chemists' Soc., 29,* 629-31 (1952).

The efficiency of antioxidants is judged by means of a modified Swift test. Addn. of 0.05% sulfur during the deodorizing process yields a 4-1.4 times prolonged keeping time of oils and fats. There is a linear relation between iodine value and the remaining speed of oxidation in % in the tests made with sulfur. The reduction of the velocity is inversely proportional to the iodine value. The effects of gallate and the sulfur seem to be additive. The residual amt. of sulfur left in the oils and fats after deodorization is very small and only slightly higher than that present in ordinary deodorized oils and fats.

Possibilities and limitations of the use of antioxidants in edible oils and fats.

Tollenaar, F. D. *II. Congr. int. Industr. agr. Roma, 27,* 21 (1952); *Brit. Abstracts, B III,* 642 (1952).

Each fat presents its own specific problems. Ultimate assessment of an anti-oxidant must be based on the organoleptic properties of the fatty product; accelerated test methods of assessment are of very limited value; and assessment should be made of the antioxidant properties under conditions closely simulating actual storage conditions in respect of packing, temp., and light. Antioxidants are restricted in their efficacy, e.g., phenolic antioxidants (gallates) are effective with animal, but not with vegetable, fats. The specific effects of a variety of antioxidants in butter, vegetable oils, animal fats, and milk powder are discussed.

A study of hesperidin and naringin from citrus fruits.

Keterson, J. W., and Hendrickson, R. *Citrus Industry, 33,* 6-7, December, 1952.

The glucoside content of four varieties of oranges and five varieties of grapefruit was studied during maturation. Mature Duncan grapefruit contained 2.5 to 3.0% naringin and mature Valencia oranges contained 1% hesperidin. From 75 to 80% of the glucoside found in the orange was concd. in the albedo rag and pulp while in grapefruit 90% was found in the same portion of the fruit.

Feeding fish meals and solubles to chickens does not affect flavor of meat.

Nilson, H. W. Comm. Fisheries Rev., 14, 41-2, December, 1952.

White Leghorn chicks were fed the following two diets: 1) about 10% menhaden fish meal, 13% condensed menhaden fish solubles, 7% alfalfa meal, and 70% ground yellow corn meal (percentages all based on wt.). 2) About 20% condensed menhaden solubles, 3% alfalfa meal, 1% cod-liver oil, and 76% ground yellow corn meal (percentages all based on wt.). After a period of time, the birds were butchered and finally cooked and tasted. The meals and condensed fish solubles which were tested (all of them low in oil) did not produce any distinct off-flavors in the chicken meat.

The physical chemistry of pectin jelly formation.

Grover, D. W. *Chem. and Ind.,* 1216-17 (1952).

A new interpretation of existing data for jelly pectin formation is proposed. This avoids some assumptions made by Hinton, and is more acceptable in the light of present ideas of the phys. state of ionized macromolecules.

A kinetic study of the removal of methyl groups from beet pectin.

Arvidsson, M., and Schiller-Meier, I. *Sockar Handlingar II, 8,* 33-7 (1952).

Expts. were performed to study the conditions of the removal of methyl groups from beet pectin, as the process takes place with the removal of acetyl groups, a procedure necessary for the production of beet pectin capable of forming jelly. Results prove that the velocity const. of the reaction is directly proportional to the hydrogen ion activity. A table is given of times for removal of the methyl groups at different temps. and pH value.

ORGANIC CHEMISTRY

A new method for acetylating proteins.

Baddiley, J., Kekwick, R. A., and Thain, E. M. *Nature, 170,* 968-70 (1952).

The ease with which acetyl derivs. reacted toward amines was applied to the acetylation of amino groups in proteins. Serum albumin was acetylated by incubation of a 2% soln. in borate buffer at pH 10.0 at room temp. with 2′ acetylthioethylacetamide (1.5%) for 3 days. Two mobile components were observed, the second component being probably due to acetylation of 5-H groups in the protein. A single treatment was sufficient to completely acetylate the protein.

The isolation and identification of quercetin and isoquercitrin from black currants.

Williams, B. L., Ice, C. H., and Wender, S. H. *J. Am. Chem. Soc., 74,* 4566-7 (1952).

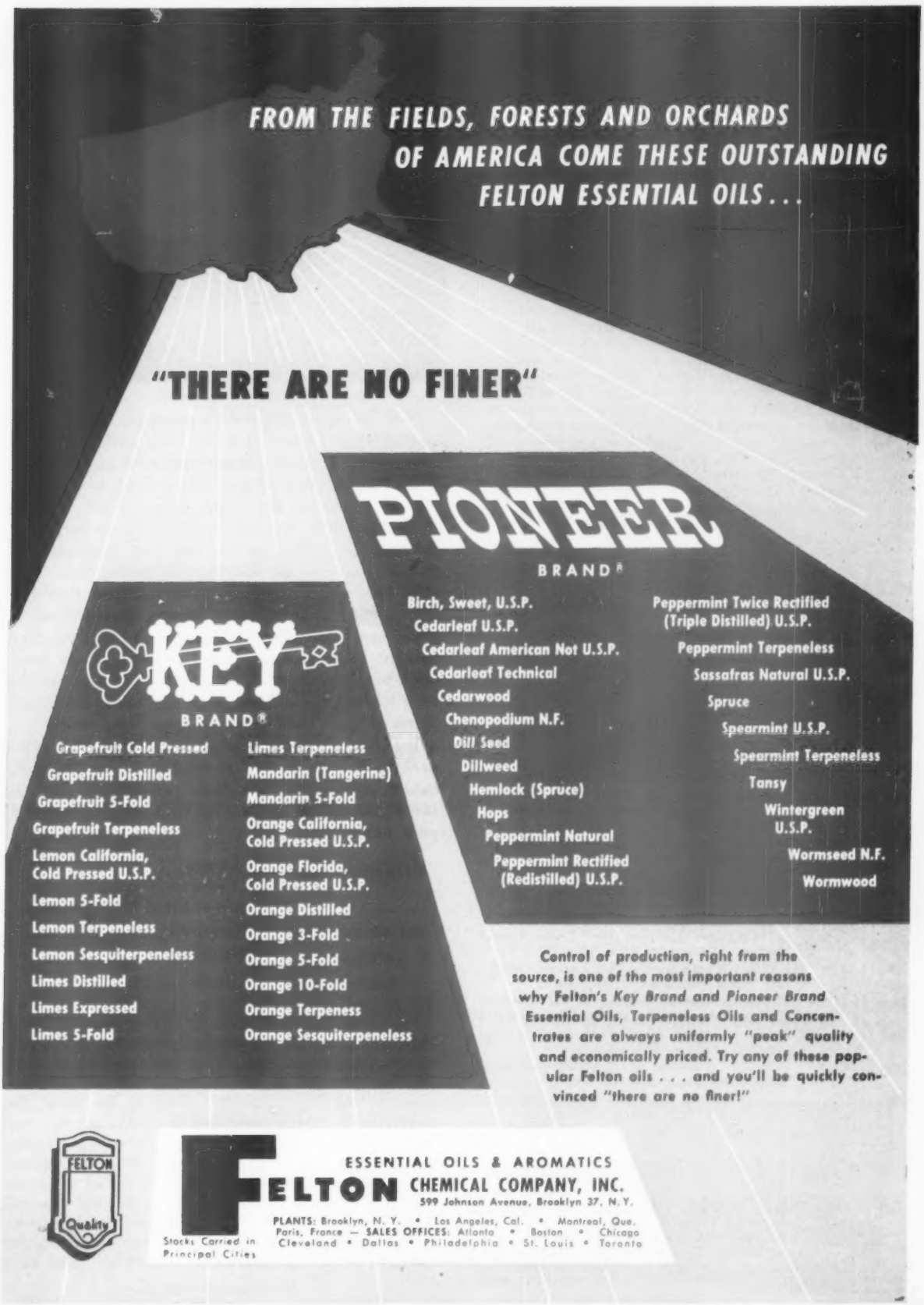
Black currants, *Ribes nigrum,* have been reported by both the guinea pig test and clinical assay method to possess a relatively high "vitamin P" activity, which is generally attributed to the flavonoid compds. present. This paper reports the isolation and identification of quercetin (3, 3′, 4′, 5, 7-pentahydroxyflavone) and isoquercitrin (quercetin-3-glucoside) from dried black currants.

PACKAGING

X-ray machine to check height of fill.

Glass Packer, 32, 26, January, 1953.

(Continued on page 16)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Peppermint Rectified (Redistilled) U.S.P.
Peppermint Twice Rectified (Triple Distilled) U.S.P.
Peppermint Terpeneless
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Spearmint U.S.P.
Spearmint Terpeneless
Tansy
Wintergreen U.S.P.
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Grapefruit Distilled
Grapefruit 5-Fold
Grapefruit Terpeneless
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Lemon Terpeneless
Lemon Sesquiterpeneless
Limes Distilled
Limes Expressed
Limes 5-Fold
Limes Terpeneless
Mandarin (Tangerine)
Mandarin 5-Fold
Orange California, Cold Pressed U.S.P.
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Abstracts

(Continued from page 14)

Reference is made to a machine to inspect height of fill of packages. The machine uses x-rays, which can detect either under-fill or over-fill, or both on the same machine. In the first condition the rays pass through the package and activate the machine, and in checking for over-fill, the failure of the rays to pass through activates the package resection device. An accuracy of 1/32" is possible. No protection for operators needed.

PHYSICAL RESEARCH

Gloss evaluation of materials.

HUNTER, R. S. *ASTM Bull.*, 48-55, December, 1952.

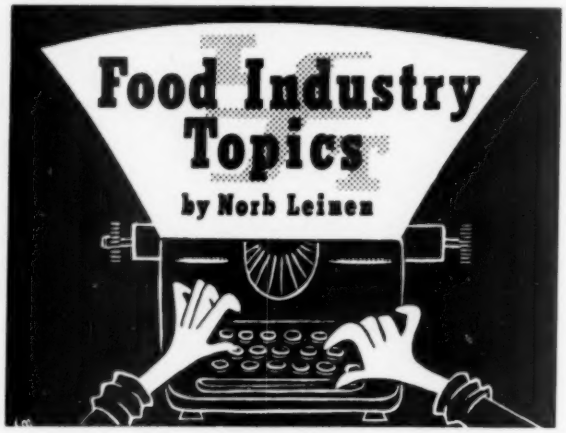
Gloss is a property of surfaces which causes them to have a shiny or mirror-like appearance. This appearance cannot be measured; only specific reflectance capacities of surfaces can be measured. Although gloss may be assocd. with the capacity of a surface to reflect like a mirror, there is no single reflectance scale yielding values that correlate with the glossy appearance of all surfaces. This is because the capacities of surfaces to reflect light in and adjacent to the directions of mirror reflection are too complex and varied to be compared on any single scale. As a consequence, different gloss scales involving different geometric aspects of light reflectance have been developed. Each provides numbers correlating with the glossy appearance of the specific types of surfaces to which it is applicable. For certain types of glossy appearance, however, correlating methods of reflectance measurement do not exist.

FUTURE DATES FOR FOOD TECHNOLOGISTS

1953

May 3-7	American Society of Brewing Chemists. Annual Meeting. Cincinnati, Ohio
May 4-6	Forty-fourth Annual Meeting of the American Oil Chemists' Society, New Orleans, La.
May 11-12	National Cottonseed Products Association. Annual Meeting. Los Angeles, California
May 12-13	American Institute of Chemists. Annual Meeting. Philadelphia, Pa.
May 20-22	International Council of Industrial Editors. Twelfth annual convention. Houston, Texas
May 25-27	Technical Association of the Pulp and Paper Industry. Fourth Conference on Coatings. Cincinnati, Ohio
May 25-28	American Association of Cereal Chemists. Thirty-eighth Annual Meeting. Buffalo, New York
May 27-29	American Society for Quality Control. Annual Convention. Philadelphia, Pa.
June 10-12	Research and Development Associates, Food and Container Institute, Inc. Sixth Annual Meeting. Washington, D. C.
June 14-18	National Confectioners' Association. Seventieth Annual Convention. New York, N. Y.
June 21-25	**Thirteenth Annual Meeting of the Institute of Food Technologists, Boston, Massachusetts**
June 22-24	American Dairy Science Association. Annual Meeting. Madison, Wisconsin
June 22-30	Eleventh Conference on the Standardization of Methods for Sugar Analysis. Paris, France
June 25-27	Twenty-seventh National Colloid Symposium, Iowa State College, Ames, Iowa
July 20-24	Conference on Microbiological Deterioration. Gordon Research Conference (American Association for the Advancement of Science) New Hampton School, New Hampton, New Hampshire.
July 27-31	Conference on Statistics in Chemistry. Gordon Research Conference (American Association for the Advancement of Science) New Hampton School, New Hampton, New Hampshire.

(Information concerning future dates of national and international meetings, conventions and exhibits of interest to food technologists should be sent to the editorial office.)



With this issue of Food Technology, we raise the curtain on a feature that we hope will make the publication of even greater value to our readership. The purpose of this column will be to keep you informed on the "who, what, when, where, and, if possible, the why" of events in the food industry. As columnist for this new "department of vital industry statistics" we introduce Mr. Norbert J. Leinen, a member of the Scientific Publications Office staff of the Chicago Quartermaster Food and Container Institute. It will be Mr. Leinen's pleasant assignment to serve as the food industry's "town crier" on events of interest in the food world. He will welcome any news items and pictures you send him on new equipment or processes, innovations in service, plant additions, personnel changes and promotions, recently published brochures, catalogs, specifications — in short, the news YOU are making. Please forward your material to:

Norb Leinen
Food Industry Topics
Institute of Food Technologists
176 W. Adams Street
Chicago, Illinois

IN preparing the material for this maiden venture, we were most fortunate in having at our disposal a mailbag that had assumed nearly behemoth proportions just before we went to press. No free samples or even money in among any of the news releases, bulletins, catalogs, etc., unfortunately, although we sifted the material with careful attention to such a possibility. But what did arrive was even more welcome to a budding columnist—a wealth of interesting facts and figures about yourselves, your companies, and your products. Good! The purpose of this column is to serve you, and it will serve you right if you keep those excellent news items coming this way. It will also mean more regular paydays for your columnist. So—for all our sakes, keep

(Continued on page 18)

The public loves good vanilla flavor.

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Be guided by the recommendations of a house you can trust and buy the best grade of vanilla you can afford. A bargain vanilla is often expensive in the long run.

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Alva FLAVORS

Food Industry Topics

(Continued from page 16)

the mailbag bursting. In other words—let's hear from you regularly!

◆ ◆ ◆

To lead off the column for May, we have a series of announcements from Brown Instruments Division of Minneapolis-Honeywell Regulator Company on new technical literature available. Among the items you can obtain for the asking are the following new specification sheets on Brown flow meters:

Specification Sheets 241 through 247

This set of seven new specification sheets in consolidated style covers flow meter line. Specification Sheets 241 and 242 cover electric evenly graduated flow meter bodies and mechanically evenly graduated flow meters respectively. Specification Sheets 243 through 247 cover square root flow meters and liquid level meters. Specification Sheet 244 also includes evenly graduated electric flow meters (inductance bridge receivers).

Two other specification sheets cover Brown pneumatic receivers and indicating millivoltmeters as follows:

Specification Sheet 285

Describes Brown pneumatic receivers which are furnished as indicating controllers, recorders, and recording controllers.

Specification Sheet 115

Describes indicating pyrometers, resistance thermometers, and tachometers of the high resistance millivoltmeter type.

The Specification Sheets listed above provide construction and engineering details in addition to complete descriptions and photographs. Other literature now available from Honeywell includes the following:

Instrumentation Data Sheet 11.0-7

Describes "Test Chambers by Bowser," presenting basic instrumentation data on all types of test chambers including those for relative humidity, low temperature, altitude, flight similitude, and environmental tests. Also included is engineering data and general specifications for standard Bowser reach-in and walk-in test chambers.

Instrumentation Data Sheet 10.18-2

Describes the Ametron electronic scale which employs the servo technique for industrial weighing utilizing Brown components and instruments. These electronic scales operate from standard Baldwin load cells employing the well-known strain gauge principle and are designed for practically all commercial and industrial weighing problems. Data sheet describes operation and application of the equipment for cranes, platforms, railroad tracks, etc. It gives the tonnage capacity of various units and shows diagramatically how they can be employed.

Bulletin 15-16

Contains technical data on the application of power measurement transducers to process control, including application data on all subjects such as salt, operation, pulverizing, clay mixing, sodium production, and measurement and control of A-C power plus the measurement and control of D-C power. Engineering descriptions of applications of thermal converters, solenoid-plunger ammeter, torquemeter, vacuum thermocouple, rectifying current system, precision shunt, saturable reactor and magnetic amplifier are covered. 12 pages.

Bulletin 501-S

Describes operation, features, and applications of new flexible temperature-time program controller. Components and specifications are included.

Catalog 1053

Describes Brown Millivoltmeter Type Instruments: Indicators, Indicating Electronic Controllers and Excess Temperature Safety Cut-off Controllers. Information on operation and applications of on-off, two-position, three-position and "pulse type" time-proportioning controllers is included as well as data on primary measuring elements, dimensions, ordering information, and scale selection tables. 20 pages.

Catalog 1530

Describes all types of "ElectroniK" control instruments used to measure and control a multiplicity of process variables. Includes detailed specification and control action descriptions and ratings for both electric and pneumatic type controllers. Also presents engineering data on the "Electr-O-Line" and "Electr-O-Pulse" electric control relays. 56 pages.

Any of the literature described above can be obtained by writing to: Mr. S. D. Ross, Manager, Editorial Department, Minneapolis-Honeywell Regulator Company, Brown Instruments Division, Wayne and Windrim Aves., Philadelphia 44, Pa.

◆ ◆ ◆

A new soluble chicory powder, claimed to be the first of its kind, has been announced by American Food Laboratories, Brooklyn, N. Y. Named "Chic-Quick," and developed under the direction of research vice president Willis S. Steinitz, an IFT member, the powder will appeal to processors of coffee, instant coffee, soups, bouillons, sauces, gravies, chocolate and confectionery, bakery products, cereals, and prepared meats as a flavor intensifier, "body builder," and color enricher. Its chief advantages over crude roasted chicory, according to the manufacturer, are lower cost, ready availability, and ease of use in the production process.

◆ ◆ ◆

Terramycin, introduced in 1950 by Chas. Pfizer & Co., Inc., is now a leading factor in the wide-range antibiotic market, and the same antibiotic in oral suspension is also one of the top prescription drug specialties in the domestic drug market. These facts were revealed by Pfizer president and board chairman John E. McKeen in announcing an estimated gross sales figure for 1952 of $107,000,000, with the antibiotic division, chemical sales division, export division, and agricultural sales division being responsible for 35%, 30%, 25%, and 10% of total sales respectively. In addition to Terramycin, the company also produces a number of other antibiotics and ethical drugs. In connection with its leading product, Pfizer announces a $20,000 hog-judging contest, with a $5,000 first prize and 24 all-expense trips to the International Livestock Exposition, Chicago, in November 1953. Purpose of the contest is to promote the use of pig starter feeds in which Pfizer's Terramycin is widely used.

Also from Pfizer comes news of a *new enzyme product* called "Glucatase" which removes glucose from eggs before they are dried thus decreasing flavor, color, and solubility changes in dried egg products and increasing their shelf life. Pfizer reports that use of Glucatase makes possible incorporation of dried eggs in food mixes and other products where previously only fresh

(Continued on page 22 following technical papers)

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The Vital Story of MACARONI* ENRICHMENT

by Science Writer

This is the fourth article in a series devoted to the story of cereal enrichment

Dramatic results have been recorded about the value of enrichment in improving health. From the United States, the Bataan peninsula in the Philippines, Newfoundland and many other parts of the world comes word of the great benefits which result from enrichment.

For years, some forward-looking manufacturers of macaroni and noodle products have used enrichment to make their good foods better. They know that enrichment restores important vitamin and mineral values which are unavoidably lost in milling, and they recognize their responsibility to provide the greatest health-building benefits for the public.

Enrichment is really a simple process. It adds the following essential elements to the food during manufacture.

Thiamine—also called vitamin B_1. This vitamin helps to build physical and mental health. It is essential for normal appetite, intestinal activity and sound nerves.

Riboflavin—also called vitamin B_2. This vitamin helps to keep body tissues healthy and to maintain proper function of the eyes. It is essential for growth.

Niacin—another "B" vitamin, is needed for healthy body tissues. Its use in the American diet has done much to make a serious disease called pellagra disappear.

Iron—is a mineral used in all enrichment. It is essential for making good, red blood and preventing nutritional anemia.

Products made from semolina may be enriched by two methods. One uses small square wafers which contain all the vitamins and iron necessary to enrich 100 lbs. The wafers break up in a small amount of water which is then added to the paste. For manufacturers who use the continuous press method, a powdered concentrate of the vitamins and iron, called a premix, is available. This is added by a mechanical feeding device.

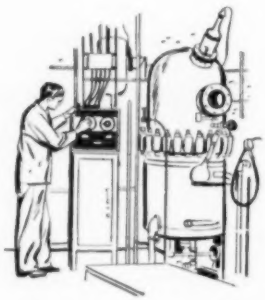
*Macaroni is used here in the generic sense. It includes all alimentary pastes: macaroni, spaghetti, farina, noodles.

These are the minimum and maximum levels, in milligrams per pound, required by the Federal Definitions and Standards of Identity for enriched alimentary pastes.

	Min.	*Max.*
Thiamine (vitamin B_1)	4.0	5.0
Riboflavin (vitamin B_2)	1.7	2.2
Niacin	27.0	34.0
Iron	13.0	16.5

NOTE: These levels allow for 30% to 50% losses in kitchen procedures.

Nowadays scientists are able to "build" duplicates of many of Nature's essential complexes in the laboratory. This has happened with many vitamins. First the chemical composition is learned and the pure substance is isolated. Then a "duplicate" is made which is identical chemically and biologically with Nature's product. A vitamin is a vitamin regardless of its source just as salt is salt whether it comes from a mine or is evaporated from the sea. So efficient is large scale manufacturing that vitamins are sold at a lower cost than if they were extracted from natural sources.



The Hoffmann-La Roche people, who produce a good percent of the vitamins used in enrichment, use amazingly complex processes with scientific production controls. This requires modern, special equipment filling whole buildings, each one a city block square and many stories high.

The combination of scientific research, thorough know-how and mammoth manufacturing processes—plus the far-sightedness of leaders in the macaroni industry—is helping vitally to make good macaroni products better.

This article, reprints of which are available without charge, is published as a service to the macaroni industry by the Vitamin Division, Hoffmann-La Roche Inc., Nutley 10, New Jersey. In Canada: Hoffmann-La Roche Ltd., 286 St. Paul Street, West, Montreal, Quebec.

The Use of Antioxidants in Dry Dog Food[a,b,c]

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American Meat Institute Foundation, The University of Chicago

(Manuscript received September 25, 1952)

The effectiveness of various antioxidants in stabilizing mixes of a dry dog food with inedible grade animal fats was investigated. Certain antioxidants of the hindered phenolic types were most effective in providing stability in dry dog food containing added fat.

A project was initiated in which it was desired to incorporate added levels of inedible grade animal fats into dry dog food. Due to the ever present problem of rancidity, it was considered desirable to investigate means of stabilizing dry dog food-fat mixtures against oxidative rancidity.

Because of the known increase in the stability of crackers, pastries, etc., which can be gained through the use of fats to which certain antioxidants have been added *(1, 3)*, this investigation attempted to elucidate the effectiveness of various antioxidants in stabilizing the animal fat which was to be incorporated into the dry dog food, and their effectiveness in stabilizing the fat-meal mixes.

The Schaal oven stability results obtained for the rations prepared in this study lacked precision; the latter fact, together with the fact that the Schaal oven method lacks an objective criterion by which rancidity is ascertained, prompted the development of a rapid and precise method for determining the relative stabilities of "dry" food materials which contain 5% or more of fat *(4)*.

This stability test is based upon the semi-quantitative detection of an accelerated appearance of carbonyl compounds in the gases exhausted from a meal sample undergoing accelerated oxidation at a time when rancid odors are organoleptically detectable.

The relative stabilities of several rations were determined by both the Schaal oven and "carbonyl" method. It was in the latter study *(4)* that the utility of the "carbonyl" method became apparent.

EXPERIMENTAL PROCEDURE

All rations containing added levels of fat were prepared in the following manner:

A commercial dry dog food[d] was ground in a hammer mill equipped with a screen with apertures of 3/32 in. diameter.

Stabilized fat was prepared by adding a solution of antioxidant in 95% ethanol to the hot (80° C.) fat. The addition of the antioxidant was followed by stirring vigorously for a period of 2 minutes.

To 1 kg. of the ground meal was added 60 or 100 g. of the desired fat which was previously warmed to 80° C. A minimum amount of hand mixing was used to disperse the fat throughout the meal. Hand mixing was followed by a 4-minute high speed mixing period with a Hobart Model A-200 mixer equipped with a wire beater.

Eight 25 g. samples of each mix were weighed into 4-oz. screw-cap jars; 4 samples were placed in room storage (26.7° C.) and 4 samples in a Schaal oven (62.8° C.). The remaining sample was placed in 2 glassine lined paper bags and put into room storage. The samples were examined periodically for the odors characteristic of rancidity. Rancidity was also determined in some tests by the "carbonyl" method.

RESULTS AND DISCUSSION[e]

Results of the study conducted to test the effectiveness of various antioxidants in stabilizing inedible grade animal fats appear in Table I.

TABLE I

The effectiveness of antioxidants in stabilizing inedible animal fats and fat-dog-meal mixes

Antioxidant Added	A.O.M. Stability Hours (P.V. = 20)		Oven Stability 63° C. (Days) Feed with 10% Added Fat	
	B White Grease	Special Tallow	B White Grease	Special Tallow
Control	10	82	23	29
0.01% B.H.A.	48	530		
0.01% B.H.A. 0.004% C.A.[f]	96	490	33	31
0.01% P.G.	56	808		
0.01% P.G. 0.004% C.A.	64	675	27	30
0.01% p-OH-D.P.A.	378	>1150		
0.01% p-OH-D.P.A. 0.004% C.A.	608	>1150	32	31

[f] C.A. = Citric Acid, P.G. = Propyl Gallate, p-OH-D.P.A. = p-hydroxydiphenylamine, B.H.A. = Butylated Hydroxyanisole.

All of the antioxidants cited showed a great degree of effectiveness in increasing the Active Oxygen Method (A.O.M.) stability *(2)* of the B White grease and Special tallow studied. However, citric acid, when used in combination with the antioxidants listed, imparted stabilities greater than those obtained with antioxidant alone. The lack of synergistic activity of citric acid with antioxidants in the tallow and the exceptionally great synergism exhibited with BHA in the grease are not compatible with experience with other fats and deserve further investigation.

Schaal oven stability results, also reported in Table I, indicate that when portions of a B White grease and Special tallow stabilized with the same antioxidants were added to a dry dog food, those antioxidants which were the most effective in stabilizing the fats were no more effective in imparting additional stability to the fat-meal mix than were the less effective

[a] A report of work done under contract with the U. S. Department of Agriculture and authorized by the Research and Marketing Act. The contract is supervised by the Eastern Regional Research Laboratory of the Bureau of Agricultural and Industrial Chemistry.

[b] Journal Paper Number 60, American Meat Institute Foundation.

[c] Presented at the Twelfth Annual Meeting of the Institute of Food Technologists, Grand Rapids, Michigan, June 8-18, 1952.

[d] Gaines meal, purchased from the Gaines Dog Food Division, General Foods Corporation, Kankakee, Illinois.

[e] It is realized that conclusions drawn from the findings discussed here cannot be applied generally since the tests were all made on one product. Differences in formulation, differences in quality of ingredients, and even seasonal differences in character of ingredients may introduce factors which will influence antioxidant effectiveness in a specific product.

antioxidants. It was of interest to note that while the tallow had an A.O.M. stability both with and without antioxidant far in excess of that of the grease, the stability of the feed with added fat was generally little different with the *2* fats. The greatest deviation was noted when no antioxidant was in the system.

In another study, rations were prepared, and their Schaal oven and room storage stabilities determined to test the effect of varying the concentration of added fat, the concentration of several antioxidants in the fat to be added to the meal, and of citric acid, when used in combination with other antioxidants, on the stability of the ration.

The room storage tests were inconclusive because all of the rations tested possessed stabilities of one year or more; during that time the rations became infested with meal moths before they became rancid.

Representative data obtained from the Schaal oven studies conducted with the aforementioned objectives appear in Table *2*; from these data, the following conclusions, verified in all the cases studied, can be drawn:

(a) The stability of the ration containing added fat, with or without antioxidants, was always greater than the stability of the original meal.

(b) The rations prepared with unstabilized fat added at the 6% level were more stable than those prepared with fat added at the 10% level.

TABLE 2

The effect of varying antioxidant concentration on the Schaal oven stability of a dry dog food [c] with added choice white grease [b]

Antioxidant Used	Oven Stability 63° C. (Days)		Antioxidant Used	Oven Stability 63° C. (Days)
	6% Grease Added	10% Grease Added		6% Grease Added
Control	49	43	0.02% Ionol	48
0.01% B.H.A.	43	48	0.01% Ionol 0.01% C.A.	41
0.02% B.H.A.	54	51	0.01% AO-2246	48
0.01% B.H.A. 0.004% C.A.	40		0.02% AO-2246	52
0.01% B.H.A. 0.01% C.A.	29	37	0.01% N.D.G.A.	47
0.02% B.H.A. 0.004% C.A.	44		0.01% *2* MeO Hq.	45
0.02% B.H.A. 0.01% C.A.	46	29	0.01% p.OH D.P.A.	42
0.01% Ionol	44		0.01% p.OH D.P.A. 0.004% C.A.	44

[c] Original Peroxide Value (O.P.V.) of meal fat = 3, Schaal oven stability = 23 days.
[b] O.P.V. = 6, A.O.M. stability = 3 hours.
Ionol = 2,6 Di tert-butyl paracresol.
AO-2246 = 2,2' methylenebis-4-methyl-6 tert-butylphenol.
N.D.G.A. = Nordihydroguariaretic acid.
2 MeO Hq = *2* methoxyhydroquinone.

The observed diminution in the stabilities of the rations prepared with antioxidant fortified greases added at the 6% level was entirely out of keeping with the known antioxidant properties of the compounds investigated. The negative effects can be attributed, in part, to the lack of precision in obtaining the Schaal oven stability results. Thus, of the 88 individual stability results used to calculate the mean stabilities reported in Table *2*, *23*, or *26*% of those results differed from the mean by 10% or more. Musty odors which were prevalent in many of the ration series studied, and which often impaired the determination of organoleptic rancidity, undoubtedly contributed to the observed lack of precision.

Table *3* shows data obtained in an attempt to determine whether the dry dog food used in the preparation of the fat-meal mixes contained constituents which limited the effectiveness of the antioxidants in preventing rancidity. Rations containing

TABLE 3

The effectiveness of several antioxidants in extracted dry dog food with 10% added choice white grease [l]

Antioxidant Used	Oven Stability 63° C. (Days)	Antioxidant Used	Oven Stability 63° C. (Days)
Control	15	0.02% Ionol	85
0.02% B.H.A.	101	0.02% AO-2246	46
0.02% B.H.A. 0.004% C.A.	93	0.02% N.D.G.A.	17
0.02% P.G.	21	0.02% p.OH D.P.A.	17
0.02% P.G. 0.004% C.A.	18		

[l] F.F.A. = 1.2%, O.P.V. = 2, A.O.M. Stability = 8½ hours.

9.1% fat were prepared by mixing meal, which had been extracted with petroleum ether (30-60° B.P.), with a Choice White grease fortified with antioxidants.

In sharp contrast with the results reported in Table *2*, all of the antioxidants studied, when incorporated into the added grease, afforded some increase in the ration's Schaal oven stability.

The study conducted with the extracted meal exemplified the following facts: (a) The most effective antioxidants [1] were the hindered phenolics, B.H.A., Ionol, and A.O.-2246 in decreasing order of effectiveness. Propyl gallate, N.D.G.A. and p-hydroxydiphenylamine afforded relatively small increases in ration stability.

(b) The dry dog food studied contained petroleum-ether extractable constituents which limited the amount of stabilization that could be gained by the incorporation of antioxidants in the added fat.

In conducting the foregoing work, the need for a rapid, objective, and precise test for the relative stabilities of the prepared rations was apparent. Moreover, a more accurate appraisal of the effect of varying the concentration of antioxidants, and

[1] B.H.A. = Butylated hydroxyanisole; Ionol = *2*,6-Di-tert-butyl paracresol; A.O.-*2*246 = *2*,*2*-methylenebis-4-methyl-6-tert-butylphenol; N.D.G.A. = Nordihydroguariaretic acid.

TABLE 4

The relative stabilities of dry dog foods determined by the "carbonyl" and Schaal oven methods

Description of Sample	"Carbonyl" Stability (Hours)	Oven Stability 63° C. (Days)	Description of Sample	"Carbonyl" Stability (Hours)	Oven Stability 63° C. (Days)
Ground Dry Dog Food	29½	20	0.01% Ionol	36¼	26
Grease [b] 5% Added [l]	30	21	0.02% Ionol	35	25
0.01% B.H.A.	33	21	0.01% Ionol 0.004% C.A.	34	26
0.01% B.H.A. 0.004% C.A.	32¼	16	0.01% AO-2246	35¼	25
0.01% B.H.A. 0.008% C.A.	34½	19	0.02% AO-2246	37	28
0.02% B.H.A.	35½	35	0.01% AO-2246 0.004% C.A.	34¼	26
0.02% B.H.A. 0.004% C.A.	36¼	33	10% Grease Added [m]	27¼	22
0.02% B.H.A. 0.008% C.A.	37½	36	0.01% B.H.A. 0.004% C.A.	32	34
0.01% P.G.	31½	20	0.02% B.H.A. 0.004% C.A.	37½	36
0.02% P.G.	32¼	26	0.01% P.G.	28½	19
0.01% P.G. 0.004% C.A.	35¼	30			

[b] Choice white grease. [l] Control for samples with 5% grease added.
[m] Control for samples with 10% grease added.

of citric acid on the stabilities of the rations prepared with unextracted meal could not be made unless a test possessing the above characteristics could be devised.

After the development of the "carbonyl" method *(3)*, the effect of varying the concentration of several antioxidants and of citric acid when used in combination with other antioxidants on the stability of the fat-meal mixes were re-investigated. The results of the re-investigation appear in Table 4.

In contrast with the data presented in Table 2, those obtained using the "carbonyl" method to assess the relative stabilities of fat-meal mixes showed that all of the antioxidants studied increased the stability of the fat-meal mix except in the case of sample No. 109 which contained added grease treated with 0.01% propyl gallate. Increasing the antioxidant concentration from 0.01% to 0.02% increased the "carbonyl" stability in all cases except when Ionol was used; increasing the citric acid concentration, when used with B.H.A. and propyl gallate but not with Ionol, or A.O.-2246, gave a ration stability slightly greater than that obtained with antioxidant alone.

Again, several anomalous Schaal oven results were obtained in this study comparing the "carbonyl" and Schaal oven stabilities. However, it can be observed that although no exact numerical correlation was found to exist between the stabilities assessed by the two methods, the results do indicate that the same trends which occur in the Schaal oven data also occur in the data obtained by the "carbonyl" method. The utility of the "carbonyl" method for practical accelerated testing of dry dog food was well established in this study.

SUMMARY

The effects of antioxidants in stabilizing dry dog food containing added inedible grades of animal fat have been investigated. Schaal oven and room storage tests indicated that added levels of unstabilized, inedible grade animal fats did not have deleterious effects on the stability of a dry dog food.

Materials present in the petroleum ether extractable portion of the dry dog food limited the effectiveness of the antioxidants studied in protecting the fat-meal mixes against oxidative rancidity.

Phenolic antioxidants of the hindered or partially hindered type appear to be the most effective for stabilizing the fats in a complex system such as dry dog food.

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A New Method for Measuring the Development of Rancidity[a,b,c]

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(Manuscript received September 25, 1952)

A rapid, objective and precise method has been devised for the determination of the relative stabilities of dry dog food materials containing 5% or more fat. The method is based upon the colorimetric determination of volatile carbonyl containing compounds formed when the fat becomes rancid.

In a study of the effect of various antioxidants in fat added to dry dog food it was found very difficult to evaluate rancidity by the usual organoleptic methods. The Schaal oven stability results obtained for the dry dog food with added fat used in this study lacked precision (Neumer and Dugan, *4*); this fact, together with the fact that the Schaal oven method lacks an objective criterion by which rancidity is ascertained, prompted the development of a rapid and precise method for determining the relative stabilities of "dry" food materials which contain 5% or more of fat.

An accelerated method for determining the relative stabilities of cereal type products has been reported by James *(1)*. The method was based upon the quantitative determination, by reduction of $KMnO_4$, of oxidizable materials in the gases exhausted from a cereal sample that was aerated at 97° C. It was concluded that the accelerated formation of those materials could be correlated with the onset of rancidity.

Since it is generally believed that compounds imparting the characteristic odor to rancid fat are primarily those containing functional carbonyl groups, it seemed plausible to expect that, at the time rancidity can be detected organoleptically in the gases exhausted from an aerated meal sample, an increased number of carbonyl compounds in the effluent gases could be detected by physico-chemical means.

A method by which the quantitative determination of traces of carbonyl compounds could be effected was reported by Lappin and Clark *(3)*. A rapid, objective, and precise method was thus developed for the determination of the relative stabilities of meals that contain fat by the adaptation of this method, and by modifying the standard A.O.M. apparatus *(2)* in such a manner that the relative concentrations of carbonyl compounds in the gases exhausted from a meal sample undergoing

[a] A report of work done under contract with the U. S. Department of Agriculture and authorized by the Research and Marketing Act. The contract is supervised by the Eastern Regional Research Laboratory, Bureau of Agricultural and Industrial Chemistry, USDA.

[b] Journal Paper Number 66, American Meat Institute Foundation.

[c] Presented at the 12th Annual Meeting of the Institute of Food Technologists, Grand Rapids, Michigan, June 8-18, 1952.

accelerated oxidation could be determined at periodic intervals.

To determine the applicability of this method for accelerated stability testing, a study was conducted on a progressively oxidized dry dog meal containing added fat. This study was made to compare the production of carbonyl compounds as measured by the newly devised accelerated stability test with the concentration of carbonyl compounds and peroxides in the meal-fat.

EXPERIMENTAL PROCEDURE

A. The apparatus and procedure used in the determination of relative stabilities by the "carbonyl" method are as follows: An individual unit of the modified A.O.M. apparatus *(2)* is shown in Figure 1. Features of the apparatus are:

(a) Calibrated capillaries (see i).
(b) Gum rubber connections.
(c) One-hole rubber stoppers.
(d) Standard A.O.M. oil bath.
(e) Rack designed to hold 18 U-tubes.
(f) Hydrogenated tallow.
(g) Pyrex U-tubes (*20* x *200* mm.).
(h) Sample.
(i) Capillary tubing (½ mm.). Capillaries A and I, when attached in series to the air supply manifold, deliver 0.60 cc. of air/sec.
(j) Two-hole cork stopper.
(k) Test tube, 16 x 150 mm. calibrated to contain 10 ml.
(l) Benzene.

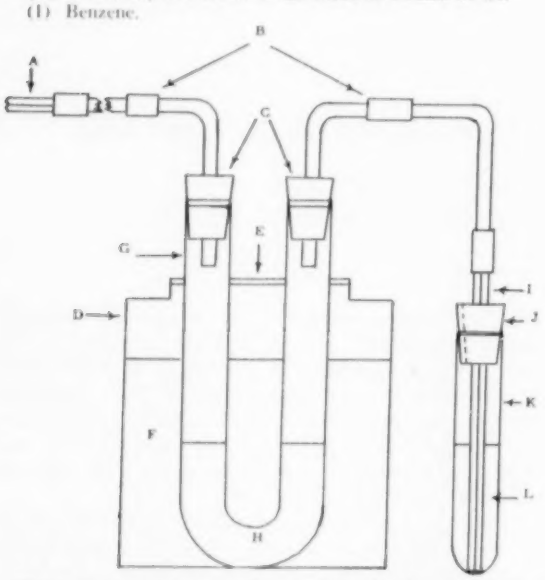

Figure 1. Apparatus used in the determination of the "carbonyl" stabilities of dog foods.

When the relative stability of a meal sample was to be determined, *20* g. of the material to be tested was placed in the U-tube and firmed by tapping so that the sample offered uniform resistance to air flow. After bringing the sample to the temperature of the bath (97.5° C.), the inlet tube was attached, the time recorded, and after allowing aeration to occur until excess water had been driven from the sample (generally *2* hours), the exit capillary was attached.

At periodic intervals, the lengths of which were determined by the stability of the sample and the approach of the break in the induction period, the effluent gases were allowed to pass through 10 ml. of reagent grade, thiophene-free benzene for a period of ½ hour; the time at which the carbonyl sample was collected was recorded. The relative concentration of carbonyl compounds in a 1-ml. aliquot of each 10 ml. effluent carbonyl sample was then determined according to the method of Lappin and Clark *(3)*. If their procedure is followed exactly, a volume of solution is obtained, the optical density of which can be measured at 480 mμ without further dilution by means of a Coleman Junior spectrophotometer.

B. The data used for comparing the production of carbonyl compounds by a rancid dog meal and the peroxide value of the meal fat were obtained in the following manner:

Sixteen *20*-g. samples of a ration were prepared by mixing 148 g. of a Choice White grease (F.F.A. = 1.2%, O.P.V. = 2, A.O.M. stability = 8½ hrs.) with 1480 g. of dry dog food,[a] from which the fat had been previously extracted (Soxhlet) with *30-60°* C. petroleum ether. These samples were placed in U-tubes and simultaneously aerated in the manner used for determining the "carbonyl" stability (see Experimental Procedure A).

At *2*-hour intervals, starting with the 24th hour of aeration, an effluent carbonyl sample was collected from one of the sixteen samples, and the relative concentration of carbonyl compounds present determined by the method of Lappin and Clark.

Aeration of this meal sample was discontinued immediately after the collection of the effluent carbonyl sample while aeration of the remaining samples was continued until each in turn was removed from the bath. A desiccated *26* x *60* mm. fat-extraction thimble containing approximately 5.5 g. of the meal was weighed to the nearest mg. The sample was then continuously extracted with *35* ml. of thiophene free, reagent grade benzene for ½ hour in a Bailey-Walker apparatus. The thimble containing the extracted meal was dried in an *80-90°* C. oven for 16 hours, reweighed, and the weight of fat obtained by difference.

The benzene-fat extract was diluted such that one one-thousandth of the quantity of extracted fat was present in 1 ml. of benzene solution. The concentration of carbonyl compounds in the diluted benzene-fat solution was determined using a modified procedure of Lappin and Clark. To 1.00 ml. of a benzene solution containing 0.5 to 0.8 mg. of fat/ml. in a *25* x *200* mm. test tube is added 1.00 ml. of a saturated solution of *2,4*-dinitrophenylhydrazine in carbonyl free methanol. The *2,4*-dinitrophenylhydrazones are formed in the usual manner.[e] To the resulting solution of the *2,4*-dinitrophenylhydrazones is added, with shaking, 5.5 ml. of a solution prepared in the following manner:

To 80 ml. of carbonyl free n-butanol is added a solution of 10 g. of KOH in *24* ml. water; the resulting solution is made homogeneous by adding 30 ml. of carbonyl free methanol.

The optical density (O.D.) of the resulting solution was read at 480 mμ with a Coleman Junior spectrophotometer, and the carbonyl concentration determined by comparing the O.D. of the fat carbonyl sample with a Beer's Law curve established by running an identical analysis on 10^{-4} to 10^{-6} molar solutions of vanillin in benzene. The concentration of carbonyl compounds in the fat was expressed as the carbonyl value, defined as the number of millimoles of functional carbonyl groups[f] present in 1 kg. of fat.

Evidence was obtained from reduced and non-reduced rancid fat samples which indicated that peroxides do not interfere with the above carbonyl determination.

An additional 8 to 10 g. sample of the oxidized meal was continuously extracted for 45 minutes with peroxide-free ethyl ether, and the weight of fat in the ether extract was determined in a manner similar to that used in the carbonyl value determination. The ether was vacuum distilled from the extract and the peroxide value of the meal-fat was then determined by the method of Wheeler *(5)*.

DISCUSSION

The stabilities of dry dog food samples containing 5% added Choice White grease fortified with 0.01% and

[a] Gaines Meal, purchased from the Gaines Dog Food Division, General Foods Corporation, Kankakee, Illinois.

[e] Five minute heating period at 100° C.

[f] A functional carbonyl group = any carbonyl group or immediate carbonyl precursor which will react with *2,4*-dinitrophenylhydrazine under the conditions of this test to yield a *2,4*-dinitrophenylhydrazone.

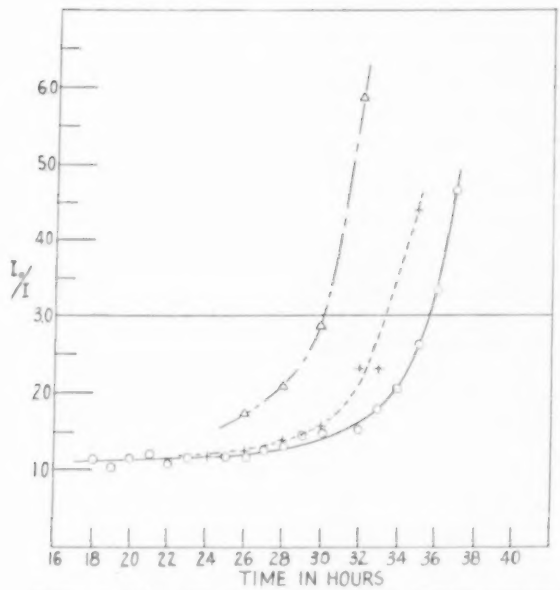

Figure 2. Io/I (480 mμ). For developed effluent carbonyl sample versus time of aeration. △, control; +, 0.01% BHA; ○, 0.02% BHA. (Dry dog food with 5% added Choice White grease.)

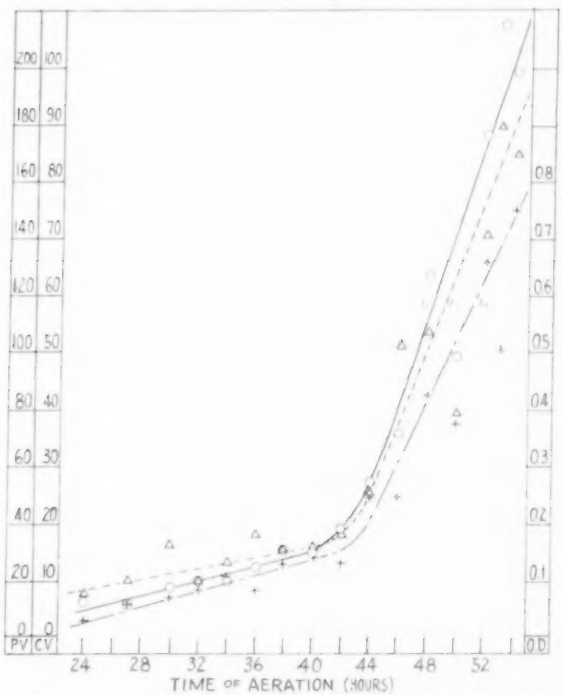

Figure 3. The changes occurring in the meal-fat P.V. (○-○) and C.V. (△—△), and the O.D. (480 mμ.) of the developed effluent carbonyl sample (+—·—+) with increasing time of aeration. Time for the P.V. and C.V. curves is that indicated on the abscissa plus ½ hr., for the O.D. curve, plus ¼ hr.

0.02% butylated hydroxyanisole (B.H.A.) were determined by the "carbonyl" method. When the relative concentrations of carbonyl compounds in the collected effluent samples, expressed in the units Io/I, are plotted against time of aeration, the curves which result, such as those in Figure 2, possess the characteristic features of induction curves.

It has been found desirable to define the relative stability of a feed as the time of aeration required for a developed, effluent carbonyl sample to attain a specific value of Io/I. This value of Io/I, the index of rancidity, is so selected that in each case under consideration, the line defined by the index of rancidity and the induction curve intersect beyond the break in the induction period, and on that portion of the curve whose slope is sufficiently great and well defined. The carbonyl stability results in our studies were determined using Io/I = 3 as the index of rancidity.

The relative stabilities of eight replicate dog food samples containing added fat were determined using the above criterion; the average deviation from the mean stability (50 hours) was 1%.

The study conducted to compare the production of carbonyl compounds by a rancid meal with the peroxide value of the meal-fat was designed to determine the following relationships:

(a) The relationship between the rate of production of peroxides and the rate of production of carbonyl compounds in the fat present in the ration undergoing accelerated oxidation.

(b) The relationship between the peroxide value and carbonyl value of the meal-fat, and the optical densities of developed effluent carbonyl samples, at any time during aeration.

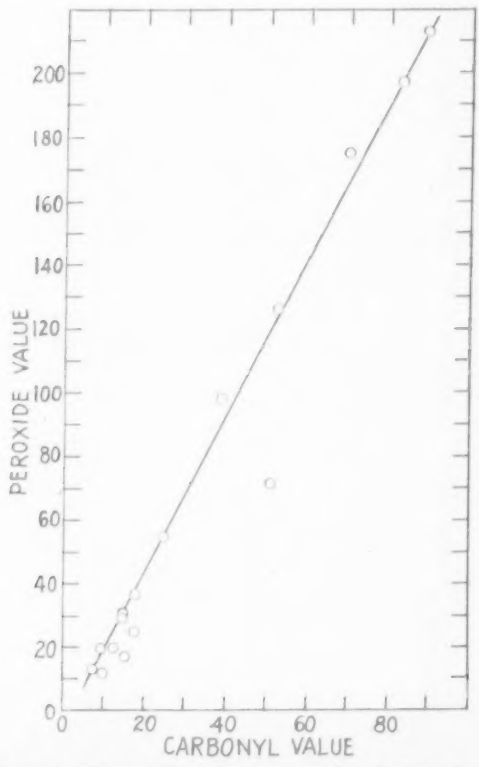

Figure 4. The peroxide value versus carbonyl value of meal-fat extracted from meal aerated for varying periods of time.

The plots of the data obtained in the latter investigation, the peroxide value (P.V.), carbonyl value (C.V.), and the optical density (O.D.) of the effluent carbonyl sample, *versus* time of aeration are shown in Figure 3.

It can be seen from curves 1 and 2 of Figure 3, that a rapidly accelerated production of carbonyl compounds in the fat in the meal undergoing accelerated oxidation occurred at exactly the same time as did that of the peroxides; i.e., the break in the P.V. and C.V. *versus* time curves occurred simultaneously. Moreover, the break in the O.D. of effluent carbonyl sample *versus* time curve occurred only 0.75 hour later than did the breaks in curves 1 and 2.

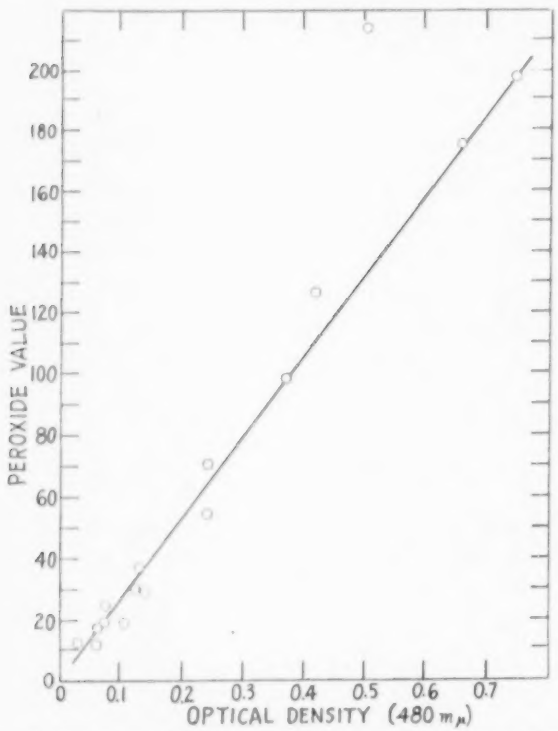

Figure 3. Relationship between the peroxide value of the meal-fat and the O.D. of a developed effluent carbonyl sample.

When the P.V. of the meal-fat at any time of aeration was plotted against the C.V. at the same time, the linear curve represented in Figure 4 resulted. Thus, over the time interval studied, it was determined that mM. of meal-fat peroxides = 1.2 mM. of functional carbonyl groups in the meal-fat.

The linear curve (Figure 5) which resulted when the peroxide value of the meal-fat was plotted against the O.D. of the effluent carbonyl sample indicated the soundness of the criterion used in determining the relative stabilities of meal samples by the "carbonyl" method.

It is believed that the "carbonyl" method affords a rapid, precise and objective means for comparing the stabilities of dry foods containing 5% or more fat.

SUMMARY

A method has been developed for determining the relative stabilities of dry dog food materials containing fat. The method is a physico-chemical method based on the colorimetric determination of volatile "carbonyl" containing compounds formed during accelerated aging by air at elevated temperatures of food materials containing fat. Excellent correlation was obtained between the criterion for relative stability used in the "carbonyl" method and the peroxide value of the fat present in the meal undergoing accelerated oxidation.

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Military Subsistence Requirements Reflect Circumstances of Use[a]

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(Manuscript received July 17, 1952)

Five thousand miles is an incredible distance to travel on horseback—particularly during the rigors of a Russian winter. Yet, some 700 years ago, the tough, seasoned troops of Genghis Khan rode through summer heat and winter blizzards—from the Yellow Sea to Kiev—to the gates of Europe. This primitive army, as it plundered and pillaged its way westward, "lived off the land" in the most absolute meaning of that expression. Sometimes, however, crop failures or a "scorched earth policy" on the part of the defenders rendered the land bare. The Mongol warrior, confronted by what

[a] Presented at the Twelfth Annual Meeting of the IFT, Grand Rapids, Michigan, June 11, 1952.

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we have come to call a "survival situation," solved his problem by direct action. He killed his horse and drank its blood—through a straw which he carried for just such an emergency. A crude expedient, certainly, but one which reveals the fact that the feeding problems of armed forces—even the problem of survival when normal supply sources fail—are not new.

Today, survival feeding as well as other military feeding problems are not so easy to solve as were those of 700 years ago. Technological advances have revolutionized modern life, and accompanying social, economic, and cultural changes have given us attitudes much different from those of an earlier time.

Thus, today, we Americans, it must be admitted, are a comfort-loving people. We have become—as compared to yesterday—sophisticated in our attitude toward food. As a consequence, it is difficult to imagine an American Army living off the forage and booty of a conquered land. It is virtually impossible to picture an American soldier downing the blood of a horse, regardless of circumstances. It is true, of course, that the American serviceman in a surprisingly short time learns to endure many hardships that are second nature to those inured to war from birth—attack by the enemy, heat, cold, lack of sleep. But through it all he likes to be assured that there is available to him good food and plenty of it. He is willing to live for a time on Spartan fare, but not for long. Food habits and preferences built up in civilian life are too strong for him as was demonstrated in World War II *(4)*. It is not the policy [*] of the Armed Forces to ignore these preferences and habits. In fact, much time and effort has been expended to find out precisely what they are and to take steps to reflect them in the menus.

The over-all problem. Technological advances, as mentioned, have increasingly complicated life—and perhaps nowhere more than in the feeding of modern armies. To paraphrase General Sherman's famous remark, "modern war is hell on wheels." With units as large as divisions and army corps moving with great speed, the business of keeping huge bodies of troops supplied with the proper rations is no longer the fairly simple matter it was during the Civil War, nor even during the trench-warfare days of 1917 and 1918.

THE BASIC REQUIREMENTS

It should be evident to everyone that since our overseas forces cannot and do not live off occupied territory in any real sense—as a matter of fact, it is usually just the other way around—they must be provided with packaged subsistence from this country. Furthermore, due to stringent military requirements, the food provided must be easy to issue, must withstand rough handling, and remain stable under the long storage normal to military supply channels. Add to these requirements the fact that nutritional values and acceptability must be retained during this period, and you have the elements of the problem. The hard fact is that very few civilian food items and very little civilian packaging are precisely adapted to meeting such requirements and therefore must be modified—in some instances extensively modified. This sometimes frustrating job of adapting existing foods and containers to Armed Forces use, of suggesting new methods of processing, and of designing new items for specific situations in the field is the function of the Quartermaster Food and Container Institute. The end results of the Institute's work, insofar as they apply to food, are embodied in the specifications for the various operational rations and their components. Many of you have had first-hand experience with our specifications and have had an opportunity to comment on their efficacy. On occasion you may have doubted the need for the stringency of their requirements.

In developing rations, however, the Institute must keep in mind the military "facts of life" just outlined. Based on these, five guideposts have been established which point to the desired goal—military effectiveness. They are: (a) utility throughout transportation, handling, storage, issue, and consumption in varied operating situations; (b) nutritional adequacy even after prolonged and sometimes extremely adverse storage; (c) stability, particularly of items of critical concern because of certain vulnerabilities inherent in their constituents; (d) acceptability, with special reference to processed foods which tend to lose their appeal for the serviceman since their flavor and texture are not that of the fresh products; and (e) manufacturing feasibility.

To make clear what is involved in each of these basic objectives, a brief amplification of their meaning in terms of military situations is in order. Functional design, or the *utility* feature of rations (Figure 1, A), includes considerations both as to the food components and the packaging and packing of the ration. Foods, it will be noted, must be capable of easy and rapid preparation in the field and be usable in both routine and unexpected operational situations. For many operational situations connected with combat-patrol duty, for example, they should be edible either hot or cold. Since heating facilities at or near the line of resistance are rarely if ever permitted due to the danger of exposing a position to the enemy, edibility in the cold state is a basic requirement. Hamburgers with Gravy, for example, a favored C-ration item, is excellent when heated, but not so acceptable when it is necessary to eat it in the cold state, largely because of the rather high fat content of the gravy. This example emphasizes a definitely limiting factor in developing products for individual combat use; namely, the somewhat narrow range of selection we have when it comes to products that can be eaten in the cold state. Not many have the taste or appeal that they have when heated.

Containers also must be easy to handle, store, and issue. In the case of individual ration containers, they should be of a size and shape to make for easy and safe carrying on the person. Obviously, they should be easy to open. Other utility factors that must be considered include those of space and weight. There is never an excess of shipping or storage space in military operations. Odd sized containers are particularly unpopular since they waste space and are difficult to stack.

The ultimate object of all rations is, of course, to provide the fighting man with the best attainable nutrition *(3)*. Foods must be sufficiently rich in nutrients to sustain him during heavy and prolonged activity, be relatively easy to digest—owing to conditions of military life that may sometimes be disturbing to bodily processes—and should contribute essential nutrients in the proportions optimum for health. Difficulties in the way of achieving these objectives are shown in Figure 1, B. They include the ever-present limitations of space and weight—a problem, important in the design of almost all rations but a particularly mean one to solve in the case of the survival ration, where considerable food value must be concentrated in a small package. The highly limited stowage space normally available on planes and lifeboats, the impossibility of predicting the number of days the ration will be needed, and the fact that water is likely to be in limited supply (even in lands of snow and ice) makes the design of a survival ration that will fulfill many purposes a problem of algebraic complexity. There are still many unknowns.

In Figure 1, B, under the heading—"Best Attainable Acceptability to Assure Adequate Intake," some of our acceptability problems may be visualized. Foods must not only *be good* for

[*] It should be made clear that this and other references to policy are not to be taken as official statements of the Department of Defense. Any final statement of policy would have to include such considerations as the fact that operational situations vary. In some instances, where it is necessary to train troops for the rigorous conditions of combat, it is equally necessary to accustom the trainees to the use of rations whose components are not in a form familiar to them in garrison or civilian life.

DESIRED CHARACTERISTICS OF RATIONS AND COMPONENTS

A. OBJECTIVES AS TO FUNCTIONAL DESIGN

Foods	*Containers*
Ease and rapidity of preparation	Readiness of issue
Edibility—either hot or cold	Ease of handling and storing
Versatility of use in field	Ease of carrying on person (individual rations)

SOME OBSTACLES TO OVERCOME

Limitations of space and weight imposed by shortage of shipping and/or storage facilities
Limitations due to food characteristics and manufacturing facilities

B. NUTRITION AND ACCEPTABILITY

Adequate Nutritive and Caloric Properties	*Best Attainable Acceptability To Assure Adequate Intake*
Sufficient amounts of vitamins and other nutrilites	Optimum color, odor, texture, flavor
Best attainment of body reserves	Adaptation of rations to food preferences of Americans of military age
Attainment of best composition of rations to optimum metabolism	Sufficient variety to prevent monotony of diet and resulting waste

SOME OBSTACLES TO OVERCOME

Difficulty of reconciling opposing needs, e. g. adequate nutritive properties and limited size of food packet as in survival feeding	Limited stability of nutrilites
	Adversities of military supply lines and storage, resulting in food deterioration
Limitations of space and weight	Inadequate and faulty preparation for consumption

C. STABILITY

Prolonged Shelf Life; Extended Stability

Foods	*Containers*
Canned, dehydrated, frozen, cured, and otherwise processed foods that retain their acceptability and nutritive properties through extended storage	Adequate packaging and packing design to protect against handling and storing hazards
	Barrier materials resistant to damage by heat, air moisture, flavor transfer and other spoilage factors

SOME OBSTACLES TO OVERCOME

Natural instability of foods and food constituents under processing and storage conditions	Extreme climatic conditions encountered in supplying and storing rations for use in remote areas of the world
	Handling hazards of military supply lines

Figure 1. Primary problems of food and container research and development with respect to: A, design; B, nutrition and acceptability; C, shelf life.

the serviceman, but must *taste good* to his critical palate, and *look good* to his critical eye. For only if the ration is consumed will its nutritional value be realized. This whole problem is one that has many ramifications—most of which lead sooner or later into the requirements written into specifications. Among factors of concern are color, odor, texture, and flavor. Can these be defined for use in specifications? We are trying to do so.

Whether or not ration foods are of the type and variety preferred by most Americans of military age is yet another aspect of the problem. *Acceptability*, that is, the palatability of rations, is of paramount importance in military situations where the basic foods are processed foods. Another problem is the preparation and cooking techniques used. Two of the greatest enemies of good acceptability are the deterioration to which rations are subject through faulty handling procedures and faulty cooking by kitchen personnel. Rations such as the "A" and "B," designed for large-group feeding, are the chief victims. Anyone who has served in the Armed Forces is well aware that the messes of certain units enjoy a reputation for the quality of their food; this can only be attributed to the ingenuity and skill of their cooks. It is advisable, of course, that all messes should have a reputation for good food. To achieve this, rations that are nearly proof against unskilled cookery as it is possible to make them must be provided. One successful step in this direction is the precooked frozen meal, now in limited use by the Air Force *(1)*. Another is the increasing use of prepared mixes by the Navy and Air Force. As an interesting aside on prepared mixes, I might mention that the limiting factor insofar as the Army is concerned is in getting prepared mixes into use "up forward." The fact is that field range ovens are not and probably cannot be designed with temperature regulators. Hence, owing to the necessity for oven control the prepared mixes have not yet gotten very close to the front lines.

Prolonged shelf life or *stability* (Figure 1, C), another of the characteristics desired in rations and ration components, presents two formidable obstacles to the Armed Forces ration planners; namely, the long periods of storage at supply points or in stockpiles and the extreme temperatures that prevail there. The storage may be of a "formal" type—as shown in Figure 2, or it may be "informal" storage under a tarpaulin or completely out in the open and exposed to the elements as is pictured in Figure 3. In extreme cases length of storage may be for as long as two years. In addition, a given ration might have to withstand cold as low as —80° F. and hot temperatures up to 160° F. as well as great variations in humidity. In some cases, rations may have to endure both these temperature extremes before reaching destination, as when a shipload of subsistence items originally destined for an arctic region may—in an emergency—have to be re-routed to the tropics. In the tropics, always hot and often humid, too, the natural or climatic heat may be greatly increased by radiation—on the decks of ships, for example, during transit. Supplies stored under tarpaulins are also subject to elevated temperatures. This intensified heat is hard on keeping quality.

Canned foods are perhaps the least affected by these hazards and are used extensively in overseas rations. Much of the keeping quality of a ration, of course, depends upon the effectiveness of the packaging and packing used in protecting the contents against handling and storage hazards *(2)*. Items packaged in containers other than metal or glass have been given much attention by Institute personnel. Damage from heat, air, moisture, microorganisms, and the transfer of flavors or odors is more likely to be sustained in foods so packaged, but the advantage of lighter materials is such that work to effect adequate packaging if this type is distinctly needed. One dream of the future is a plastic package that will withstand processing temperatures.

Manufacturing considerations. The final "fact of life" that must be considered in developing suitable operational rations is largely a civilian responsibility—namely, determining the feasibility of manufacturing a new or improved item rapidly and in volume. This can be a real problem. A newly developed item may have all the desirable qualities mentioned previously, but a scarcity of one of its ingredients, a new mode of processing that may be required, even a new shape may nullify the prime military requirement—that the product be available for use rapidly and in huge volume. Our careful study of the feasibility of manufacturing canned bread, an ideal product for military use, could be used as Exhibit A in this regard.

MILITARY REQUIREMENTS IN TERMS OF RATION TYPES

To recapitulate our requirements in terms of the various principal types of Armed Forces rations, we might

Figure 2. Rear area Korean storage site. Excellent protection is afforded supplies in storages such as these.

begin with Ration Operational, B which is shown in use in Figure 4. Three key characteristics of the B-ration are: (a) the utmost concentration of nutritional value in the most stable and palatable form attainable; (b) the greatest possible reduction of labor in preparation and cooking—a good example of success in this regard is 4-way boneless beef; (c) the greatest possible manufacturing potential in terms of available raw materials, existing food and packaging plant facilities, and, of course, cost. All three characteristics are exemplified in dehydrated products; and it is here, of course, that the ultimate in space and weight saving is effected. The Institute has an extensive program under way on dehydrated foods—a program in which many groups from Government and industrial laboratories cooperate. Dehydrated products are used, it should be stated, for other rations than the "B."

For a small group (Figure 5) a typical ration is Ration, Small Detachment, Five-in-One. There are 4 important requirements for rations used by small groups: (a) the greatest possible efficiency of issue, particularly, the optimum arrangement and number of components to assure proper distribution at the time the meals are to be eaten; (b) prolonged shelf life and, particularly, freedom from flavor or odor transfer within the carton; (c) sufficient variety of menu to prevent monotony; (d) high retention of essential nutrients to assure health while subsisting on packaged rations. Past experience has shown this last item to be a very important consideration.

For individual rations, the basic requirements are very similar to the ones just described for the Five-in-One, the most important difference, perhaps, being the fact that the basic needs change somewhat from situation to situation. Probably the most conspicuous example of a ration constructed to meet a single purpose is to be found in Ration, Individual, Trail, Frigid. A characteristic of vital importance in this ration is density of calories within a relatively small package. It is also necessary that it have immediate taste appeal. Also required is a ration that can be readily eaten despite the encumbrances of arctic gear (see Figure 6). Of perhaps even prior importance, is the necessity for a food so low in moisture content that when eaten cold, subzero temperatures cannot solidify the product into a rock-like texture and render it inedible.

Having taken note of the characteristics required of the 3 broad types of rations, the A and B, the Five-in-One, the Trail ration, it would perhaps be in order at this point to examine—more closely than has heretofore

Figure 3. Open storage under emergency conditions—Italy, 1944.

Figure 4. In front areas the B-ration, served hot, approaches stateside meal standards.

been possible—a ration, or rather food packet, designed for a highly specific purpose. A packet that meets this description is the Food Packet, Individual, Assault, also known as the Assault Packet, which consists of precooked, ready-to-eat foods so packaged as to allow easy carrying during the early stages of an assault operation or beachhead landing. At such times, even if regular rations were available (which is often not the case) it would not be desirable to issue them. For one reason, the soldier or marine is keyed up prior to such an operation and has little desire for food. For another, he simply will not allow himself to be weighed down with bulky cans of food; not only will they slow him up, they can actually cause injury when he "hits the ground"

Figure 5. Rations for small detachments must contain "much in little." The Five-in-One, food for five men for one day, can be used by radar, weather station, patrol and numerous other groups on detached assignments.

under fire. Furthermore, ammunition always comes first with the man in combat. In a choice between an extra grenade and a can of food, the can of food is likely to lose. Still, since his regular rations may not catch up with him for a day or more, a man in combat must be given something to sustain him. The Assault Packet, pictured in use in Figure 7, contains canned meat of one of 8 varieties, candy, soluble coffee, cigarettes, gum, matches, water purification tablets, and toilet paper. It seems to be a good answer to the feeding problem in situations such as that shown (Figure 7). The packet, approximately one-and-one-half pounds in weight, is of a size and shape that fits readily into a pocket. This packet is an excellent example of what can be accomplished when precise field-use requirements are established for a ration and the research and development efforts are keyed to meet these requirements.

CONCLUSION

Thus far discussion has been confined to the characteristics of rations in terms of current concepts. However, there is always the urge in military planning to attempt to pierce the veil of the future. The subsistence situation in Korea, for example, is in general good. It is true that there are a few factors—the difficulty of adjusting the Five-in-One Ration to *all* small detach-

Figure 6. Hot gruel for cold soldiers is possible from the resources of Ration, Trail, Frigid.

Figure 7. The assault packet does not provide "food for one man for one day"—the official definition of a ration—but for an initial period of combat action less than thirty hours in duration, the Food Packet, Individual, Assault, serves its purpose admirably.

ment situations, for example—which have presented problems, but on the whole the situation is in hand. In other words, if our problems in the future could be relied upon to be those of Korea or similar areas that sometimes ominous term "the future" would cause no great anxiety. But who knows what the future holds? A dramatic turn in world events could well involve feeding situations different from those of Korea. It is for this reason that we need to have a flexible ration program and scientific, military, and industrial personnel alert to new problems and experienced in the techniques used in solving the older problems. In other words, and to make this last thought more concrete, if world events should inspire military action in a theater remote in space and character from Korea, the requirements for a small group type of ration might well be again a key problem.

In closing let me stress the significance of the role industry is playing in the Armed Forces research and development program on foods and containers. While it is true that the Food and Container Institute is, in the very nature of things, the center of this work—in fact, it is the *only* organization in the Department of Defense with a clear-cut obligation to design foods for changing military tactics and supply line requirements, we have never lost sight of the teamwork that must exist and continue to exist, both within the Department of Defense and outside, if future emergencies are to be met. Actually, industry, in opening the doors to its laboratories and its plants enables us to reconcile the exacting requirements of foods for military use with the realities—or let us say the necessities—of modern volume production. Many concrete results, that is to say, end items, have come from the cooperation that has long prevailed between industry and the Institute. Four-way Boneless Beef, Prefabricated Poultry, Canned Bread, and numerous dehydrated products are but a few of the items on the long list. In the future as in the past industry's assistance will prove invaluable when new and even spectacular techniques of processing are introduced. Processing by means of irradiation may bring us new and better meat items and improved dehydrated fruits and vegetables. Dehydrated whole milk comparable to fresh whole milk, prepared cake mixes of high stability, a thermo-stable margarine—these are some random examples of problems that are moving toward solution with the aid of industry.

When it is considered that in World War I the cost of Quartermaster subsistence purchases amounted to $727,000,000, whereas in World War II it came to the astronomical total of $11,048,032,000, it can be appreciated that the Armed Forces and industry are joined together in a cooperative enterprise that is worthy of the best efforts and talents of its food and container research and development personnel.

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Influence of Processing Variables on Drying Rate and Quality of Dehydrated Frozen Sweet Corn[a,b]

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(Manuscript received January 5, 1952)

The influence of air temperature and dew point temperature during drying and of storage temperature on five attributes of quality of dehydrated frozen sweet corn was tested subjectively indicating that storage temperature exerted the only important effect.

An exponential expression of drying rate was related to the air temperature and dew point temperature in a linear regression.

Research on the dehydration of foods has indicated that the characteristics of the drying curves and the quality of the resulting product are functions of shape, size, moisture content, and permeability of the material being dried and the temperature, velocity and moisture content of the surrounding air as well as the duration of the drying cycle *(1, 2, 3, 4, 5, 6)*.

In the present preliminary study, an attempt has been made to investigate the effects of several processing variables on the drying rate and the quality of the finished product through use of statistical regression methods.

EXPERIMENTAL PROCEDURE

Frozen cut sweet corn[c] was used in this investigation. Specific information concerning the variety, date of harvest, handling, and treatment of the corn was not available. The corn was shipped frozen in bulk form. It was stored at the Food Processing Laboratory, Iowa State College, at a temperature of 0° F. (—17.8° C.) until it was taken to the Mechanical Engineering Laboratories for drying.

The corn was divided into 5 lots for convenience. A representative moisture content of each group was taken. Each of these 5 groups was then divided into 6 parts, each part weighing approximately 2200 g. This amount was used for each drying run. The representative moisture content of the corn (wet basis) was obtained by drying to a constant weight in a vacuum oven at 0-50 mm. Hg. pressure. The time required to obtain a dry solid was about 5 hours.

A simple design was used in which samples of corn were randomized over the dew point temperatures and air temperatures shown in Table 1. The treatments were applied in random order.

The air conditioning unit employed a steam humidifier and/or a F12 vapor compression refrigeration coil for humidity control of the air supply. Air temperature regulation was accomplished with a bank of finned-tube steam coils equipped with a thermostatically actuated motor operated steam supply valve. The fan speed controller was fixed so that all runs were made with an air delivery of approximately 600 cfm. Air dew point temperature (° F.) was adopted as a measure of humidity.

In all tests a through circulation air flow arrangement was used. The material to be dried was placed in 4 trays in a one-kernel thickness covering the one square foot area of the pan. These trays were placed in the drier on horizontal supports. Eight thermocouples were inserted in kernels located at random in 2 trays, 4 to record the internal, and 4 to record surface temperatures of kernels. These trays were not disturbed during the drying run. The other 2 trays were removed and weighed on a triple beam balance at half-hour intervals for the duration of the test period. Time required to weigh the samples was one minute.

Wet-bulb and dry-bulb temperatures of the supply air, inlet and outlet air temperatures and internal and surface temperatures of the corn were recorded for the entire drying schedule.

Drying was continued until the calculated moisture content in each sample was 5% or less (dry basis). The samples were then removed from the drier, taken off the trays, divided into 4 parts, placed in No. 2 cans and vacuum sealed in a mechanical vacuum closing machine and put in storage at 0° F., 70° F., and, 100° F. (—17.8° C., 21° C., and 37° C.).

After storage for 3 months the samples were rehydrated to 80% moisture content (wet basis), and subjective quality evaluations were made. Three experienced judges rated the samples on a scale from 0 to 9 for appearance, odor, color, texture, and flavor. Frozen cut sweet corn cooked in the same manner as the samples under test was used as a control with each set of samples judged.

RESULTS

If moisture level during dehydration was expressed as:

$$\text{moisture concentration} = C = \frac{\text{g. } H_2O}{\text{g. } H_2O + \text{g. bone dry solid}}$$

the drying curves could be resolved using the expression,

$$C = Le^{-Kt}$$

where:

C = Moisture concentration $\left(\frac{\text{g. } H_2O}{\text{g. wet solid}}\right)$

L = Intercept of the drying curve with zero time $\left(\frac{\text{g. } H_2O}{\text{g. wet solid}}\right)$

K = The slope of the drying curve $\left(\frac{1}{\text{time}}\right)$

t = Time of dehydration (hours).

Calculation of the K values for 30 dehydration treatments yielded the values shown in Table 1.

Observation of the values of K indicate that they vary with both inlet air temperature and dew point temperature. A description of this variability using multiple linear regression yielded the expression,

$$K = .2683 - .0062T + .0013D$$
$$\pm .0028 \quad \pm .0012$$

where:

K = Slope of dehydration curve
T = Air inlet temperature (° F.)
D = Dew point temperature (° F.)

The figures directly below the equation are the standard errors and these indicate a fairly high degree of variability in the slope estimates.

[a] Journal Paper No. J2235 of the Iowa Agriculture Experiment Station, Ames, Iowa. Project No. 1052.

[b] This paper reports research sponsored by the Quartermaster Food and Container Institute for the Armed Forces, and has been assigned Number 408 in the series of papers approved for publication. The views or conclusions contained in this report are those of the authors. They are not to be construed as necessarily reflecting the views or indorsement of the Department of Defense.

[c] Obtained from the Fairmont Canning Co., Fairmont, Minn.

TABLE 1

Slope (K) values for sweet corn drying curves

Inlet air temperature °F.	Dew point °F.	K[a]
106.40	40.00	-.4464
104.50	32.80	-.2719
105.30	31.50	-.2440
105.00	46.20	-.3042
105.00	45.30	-.4039
105.00	46.00	-.3270
105.00	60.10	-.3472
105.00	59.60	-.3208
105.00	60.00	-.3042
120.00	32.70	-.4464
121.00	45.90	-.3772
119.50	30.18	-.4723
120.80	30.30	-.4532
120.00	45.40	-.5364
119.40	45.00	-.4037
121.50	60.40	-.3773
120.50	61.40	-.3411
119.00	62.00	-.3663
134.40	33.30	-.6055
134.10	29.80	-.6680
135.00	44.00	-.3631
134.00	44.10	-.4130
135.70	44.90	-.5067
133.80	31.35	-.4782
136.50	60.00	-.5202
135.00	58.80	-.4876
136.50	60.10	-.5738
149.30	45.40	-.6829
152.00	31.90	-.6450
150.00	58.10	-.6121

[a] K = slope of regression line.

The multiple R = .8064 indicates that about 64% of the variability in this system is accounted for by the regression used. This expression should be useful in calculating approximate values of K.

The analysis of dehydrated corn samples by 3 experienced judges was made to determine the effects of inlet air temperature, dew point, storage temperature and judges on the appearance, flavor, texture, odor and color of the final product, using samples rehydrated to 80% of their original moisture content and judged in duplicate after 3 months of storage at 0, 70, and 100° F.

The general plan of the analysis of variance is shown in Table 2 to be a split-split plot analysis where the 3 high temperature treatments (150° F. inlet air temperature) were eliminated for ease of analysis. The actual analysis is summarized in Table 3

TABLE 2

General plan of the analysis of variance

Rep. S	2
Whole Plot Treatments (T)	2
Whole Plot Treatments (D)	2
TD	4
Error (a)	16
S	2
ST	4
SD	4
STD	8
Error (b)	36
Judges	2
JT	4
JD	4
JTD	8
JS	4
JST	8
JSD	8
JSTD	16
Error (c)	108
Duplication	243
Total	485

S—Storage Temperature
T—Air Inlet Temperature
D—Dew point
J—Judges

with regard to significant effects. This table indicates that storage temperature (S) was the only main effect consistently significant for all the 5 attributes of quality tested.

Two 2-factor interactions were also important: these were the judge-by-storage temperature (JS) and judge-by-dew point (JD) interactions. These interactions indicate that the difference between judges' scores changes with storage temperature and also with the dew point employed in the dehydration process.

In Table 4 are shown the judges' mean scores for each quality factor and each storage temperature. In every case, the scores are inversely proportional to the storage temperature. The scores indicate that the product stored at 0° F. and 70° F. was acceptable, i.e. scored above 5 points on the 0-9 scale.

Texture was affected least by storage temperature and rated 5.7 points at the 100° F. storage temperature. The change in color due to increased storage temperature was larger than that exhibited by the remaining attributes. The mean score of 3.1 for the 100° F. storage temperature indicates clearly that this product is not of acceptable color.

Comparison of the mean scores for storage temperatures provides evidence that the effect of storage temperature on each quality factor is non-linear. In each case, the change in score for the 70° interval from 0-70° F. is less than the change in score for the 30° interval from 70-100° F.

Individual mean scores for dew point temperature and air inlet temperature were found to have no appreciable influence on the judges scores.

Of considerable interest in assessing the degree of agreement between duplicate determinations by a single judge are the values shown in Table 5. Here it is found that duplicate scores usually vary by one score point or less; the actual proportion of the scores included in this group are 89.7% for appearance, 86.0% for flavor, 89.7% for texture, 87.2% for odor and 94.2% for color; an average for all 5 attributes of 89.4%.

TABLE 3

Summary of significant effects in the analysis of variance of subjective evaluation

	D	S	ST	JS	JD	JSD	JT
Appearance	—	X	—	X	X	—	—
Odor	—	X	—	X	X	X	—
Texture	X	X	—	X	X	—	—
Flavor	—	X	X	X	X	—	—
Color	—	X	—	X	X	—	—

TABLE 4

Effect of storage temperature on judges' mean scores of five quality attributes

Quality attribute	Storage temperature		
	0	70	100
	°F.	°F.	°F.
Appearance	6.7	6.4	4.2
Odor	6.4	5.6	4.7
Texture	7.3	7.0	5.7
Flavor	7.0	6.4	4.0
Color	8.1	7.6	3.1
Means	7.1	6.6	4.3

TABLE 5

Agreement between duplicate judgments of five quality attributes

Quality attribute	Number of duplicate judgments differing by 0-4 score points				
	0	1	2	3	4
Appearance	121	97	22	3	0
Odor	106	106	27	4	0
Texture	114	104	21	3	1
Flavor	117	92	26	7	1
Color	175	54	12	1	1

CONCLUSIONS

It may be concluded from this study on dehydration of frozen sweet corn that the temperature at which the dehydrated samples were stored exerted a great effect on all of the attributes of quality which were judged. No clear-cut effects of air temperature and dew point were evident. While variations were noted which were probably due to the judges and to the interaction of judges with storage temperature and with dew point, a consideration of the agreement between duplicate determinations indicates good agreement, most of the scores varying by 0.5 score points or less.

An analysis has also been presented to reveal the effect of air drying temperature and humidity on the drying rate. Satisfactory rate prediction may be made with the exponential equation:

$$C = Le^{Kt}$$

where K is a function of the air inlet temperature (° F.) and dew point temperature (° F.), and

$$K = .2863 - .0062T + .0013D$$

may be used to predict the drying rate (K) from the air inlet temperature (T) and the dew point temperature (D).

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A Method of Determination of Rehydration Rate of Dehydrated Sweet Corn[a,b]

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(Manuscript received December 27, 1952)

A method is presented for determining the rehydration rate of dehydrated sweet corn as a function of the processing variables. An equation is presented for prediction of rehydration rate in terms of drying temperature, dew point temperature, and storage temperature.

The complex changes which take place during preparation of dehydrated products for consumption are ascribable to the variety of recommendations for cooking and rehydration which may be found in the literature *(1, 2, 3, 7)*. The need for detailed information on the effect of processing variables on rehydration and for improved methods of rehydration have received attention from Davis and Howard *(4)* and Hand *(5)*. Methods recommended in the past *(1, 7)* have generally included time-temperature levels for soaking and for cooking under specified conditions or the suggestion has been made that changes during rehydration be followed by periodic determination of drained weight.

In an investigation of the quality of dehydrated corn it became necessary to explore the possibility of formulating an improved method for rehydrating dehydrated sweet corn to known extents. This necessity arose from the contention that any evaluation of the effects of experimental treatments applied in the production of dehydrated sweet corn may be in error if the treatments applied cause a change in the rate of drying or in the linearity of the rehydration curve of the product. If this situation obtains, and all samples are rehydrated under the same conditions of temperature for the same length of time, the resulting samples must then be rehydrated to different extents. If the extent of rehydration in any way affects the quality of the product, as it is known to do, then the resulting comparisons by treatments must be different from the set which would be obtained if all rehydrations were caused to progress to the same extent.

If the rate of rehydration or—more generally—if the form of the rehydration curve has an effect on evaluation in addition to the effect of extent of rehydration, then comparisons of treatment effects could only be made where the form of the rehydration curve is specified and similar from sample to sample. For situations in which the rehydration curves vary in form, such comparisons might be difficult, if not impossible.

[a] Journal Paper No. J-2234 of the Iowa Agricultural Experiment Station, Ames, Iowa. Project No. 1052.

[b] This paper reports research sponsored by the Quartermaster Food and Container Institute for the Armed Forces, and has been assigned number 407 in the series of papers approved for publication. The views or conclusions contained in this report are those of the authors. They are not to be construed as necessarily reflecting the views or indorsement of the Department of Defense.

EXPERIMENTAL PROCEDURE

The test originated for the determination of rehydration rate was used in an attempt to describe the characteristics of the rehydration curves of sweet corn samples dehydrated at *3* levels of dew point temperature—30, 45, and 65° F. (—1, 7.2, and 15.6° C.), *3* temperatures of dehydration—105, 120, and 135° F. (40.5, 49, and 57° C.), and *3* storage temperatures—0, 70, and 100° F. (—17.8, 21, and 37° C.). A single large sample of frozen corn of one variety was used throughout these tests. Each treatment combination was replicated *3* times.

Approximately 600 gram samples of frozen corn were evenly loaded on trays and dehydrated in a through-flow dehydrator using a constant air velocity of 600 c.f.m.

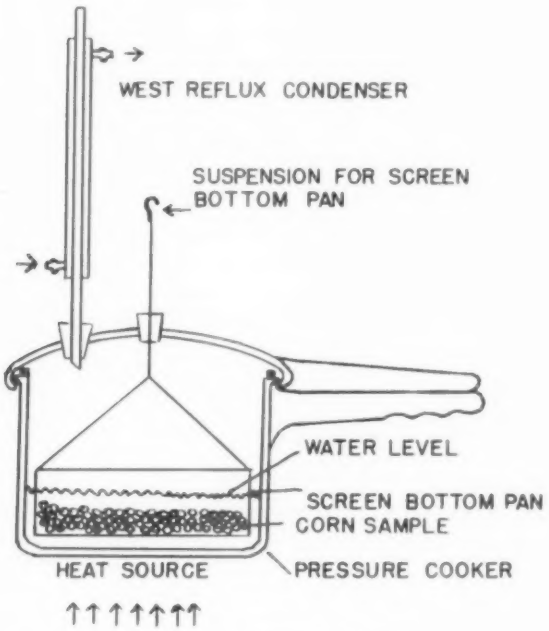

Figure 1. Rehydration apparatus.

Dehydration was continued to a moisture content of approximately 20%. The remaining moisture was removed in a bin dryer. The final moisture content was 5%.

The dehydrated product was vacuum sealed in 300 x 308 cans and stored at 70 and 100° F. (21 and 37° C.) in constant temperature incubators.

A 50-gram sample of the dehydrated corn sample was placed in a wire tray inside a 4-quart pressure cooker. The tray was made with a hanger used for suspending it from a dial scale for the periodic measurement of weight.

The pressure cooker was operated at atmospheric pressure with a reflux condenser attached to return the condensed steam to the container. A larger opening was made where the safety valve is located and a West condenser was inserted. The petcock was taken out and through this opening the wire attached to the screen pan was located. (See Figure 1.)

Seven hundred and fifty ml. of distilled water and *2* g. of salt were placed in each pressure sauce pan and brought to a boil. Electric hot plates were used as a source of heat. Fifty grams of dehydrated corn were added to the boiling water. Weights were recorded every *2* minutes until the corn reached a predetermined percent of its fresh moisture content. These readings were taken by raising the screen-bottomed pan containing the corn out of the boiling water and hooking the basket on to a device by which it was connected to a dial scale. The water was drained for 30 seconds before taking the reading. In using this method, the pan containing the corn was not removed from the pressure sauce pan. Two samples were cooked simultaneously and when cooking was completed, drained and placed in open pans to cool at room temperature.

Preliminary judging was done to determine the percent of fresh moisture to which the corn should be cooked. A test was run cooking the corn to 100, 90, 75, and 60% of original fresh moisture content. Fifty-gram samples of corn were tested by 4 judges. Results indicated that rehydrated corn at 90 and 100% of fresh moisture were water soaked and lacking in flavor while corn at 60% contained hard kernels.

Five tests were then run in which the corn was rehydrated to 90, 85, 80, and 75%. The mean scores for the 5 runs evaluated by 4 judges were: 90% — 2.9, 85% — 2.4, 80% — 2.1 and 75% — 2.6. This was a preference test using a scale of 1-4 and the 80% samples with the lowest score were preferred most often.

Corn cooked to 80% of its fresh moisture was selected as the corn resembling and tasting similar to fresh cooked frozen corn used as the raw material in this series of tests.

As a result, all the corn in subsequent tests in this series were rehydrated to 80% of the original amount of moisture present.

For other varieties and other conditions of dehydration the optimum level of rehydration should be recalculated.

RESULTS

Inspection of the rehydration curves of which Figure *2* is a typical example, indicate that samples with different treatments rehydrated at about the same rate until a weight of 125 g. was reached. Beyond this point, a considerable difference in rehydration rate was usually apparent. For this reason, and to avoid undue complication of the analysis, the rehydration curves were evaluated beginning with 125 g.

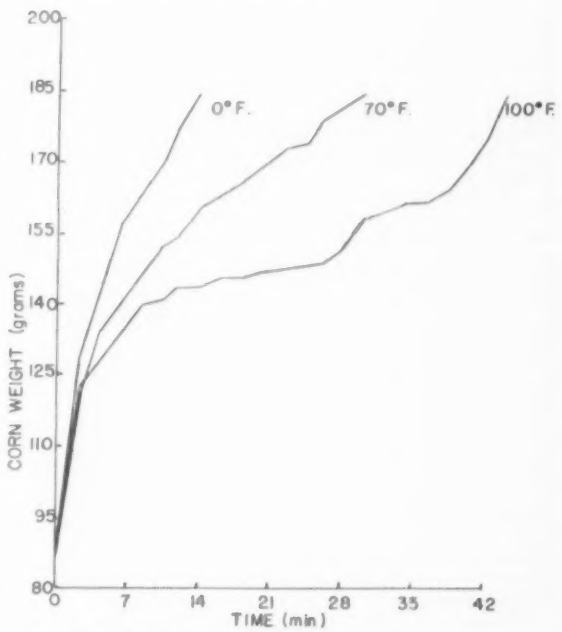

Figure 2. Example of rehydration curves for three storage temperatures, air temperature — 105° F. and dew point temperature — 60.1° F.

Linear regressions were run on these curves in an effort to create parameters which would enable the comparison of effects of varied rehydration treatments. The slope values resulting from linear regressions under these conditions are shown in Table I.

In the analyses of data on rehydration, an analysis of variance was run as a means of indicating the functional relationships between the main effects—dew point temperature, drying tem-

TABLE 1

Slopes derived from linear regressions of weight of corn vs. time of rehydration

Air temp. designated	Air temp. actual	Dew point actual	Storage temp.		
			0°	70°	100°
			Slopes of linear regression		
			β	β	β*
105	104.5	32.8	3.31	3.77	1.80
	105.3	31.5	4.04	3.84	3.87
	105.0	46.2	4.09	4.81	2.40
	105.0	45.3	2.42	1.47	1.44
	105.0	46.0	3.64	4.05	1.49
	105.0	60.1	4.48	1.83	1.06
	105.0	59.6	2.65	2.26	1.71
	105.0	60.0	3.85	2.35	1.30
	106.4	40.0	7.56	3.72	3.35
120	120.0	32.7	6.16	2.79	1.28
	121.0	45.9	5.46	5.03	2.49
	119.5	30.1	4.06	5.64	3.72
	120.8	30.3	7.01	6.86	1.63
	120.0	45.4	6.12	4.55	1.28
	119.4	45.0	4.02	3.30	2.37
	121.5	60.4	3.95	2.53	2.09
	120.5	61.4	3.74	3.41	1.53
	119.0	62.0	2.62	3.27	1.29
135	134.4	33.3	4.95	1.44	1.63
	134.1	29.8	7.55	4.38	2.25
	135.0	44.0	4.76	6.59	9.01
	134.0	44.1	6.44	3.92	2.46
	135.7	44.9	4.52	4.70	1.31
	133.8	31.3	7.06	4.70	2.20
	136.5	60.0	3.96	3.38	3.58
	135.0	58.8	2.52	3.22	1.22
	136.5	60.1	2.79	2.63	2.21

* β = slope of linear regression lines.

perature, and storage temperature—in terms of the slopes of the rehydration curves.

Results indicated that all the main effects(dew point temperature, drying temperature and storage temperature) are significant and that interactions are not significant. All of the interactions were of approximately the same magnitude as the error term, indicating that the main effects may be interpreted as additive.

Although there is some evidence of curvature in the storage temperature data a multiple linear repression was run with the following results:

$$Y = 3.468350 - .0209986\ (S) + .0264708\ (T) - .04193517\ (D)$$
$$\pm .0037470 \qquad \pm .0128670 \qquad \pm .01364510$$

where: Y = rehydration rate in g./min.
S = storage temperature (° F.)
T = dehydration temperature (° F.)
D = dew point (° F.)

The figures shown under the regression coefficients are the standard errors of the regression coefficients. The multiple R *(6)* was found to equal .618, indicating that about 38% of the variation was accounted for by the multiple linear regression used.

The question of curvelinear effects in the multiple regression was attacked by considering linear and quadratic components in the treatment as sums of squares.

This analysis indicates that for all 3 treatments, the linear effects are highly significant while only in the case of storage temperature is there a highly significant quadratic effect. Conclusions to be drawn are that a linear regression will fit well on dew point and temperature but that to obtain the best equation for prediction, a non-linear fit must be used for storage temperature.

In view of the above information, a non-linear regression of the form; $Y = + B_1S + B_2T + B_3D + B_4S^2$ should provide an improved prediction equation. Determination of the coefficients in this equation yielded the expression:

$$Y = 3.7887 + .0124S + .0265T - .0520D - .0035S^2$$
$$\pm .0155 \quad \pm .0124 \quad \pm .0132 \quad \pm .0016$$

where: S^2 = storage temperature squared.

It is assumed that the 50-gram dry sample reaches 125 g. in approximately 3 minutes.

The new regression equation accounts for 44% of the variation, as compared with 38% for the initial linear estimate.

DISCUSSION

Dehydrated corn samples prepared under varied conditions of dehydration temperature, dew point and storage temperature indicate clearly that the rates of rehydration change with the treatments and levels of treatments applied. The regression equations presented add weight to this contention and in addition, provide a means for predicting from the experimental treatments the rate of rehydration which must be expected. From this rate, the predicted time necessary to reach any level of rehydration may be calculated.

In view of these facts, it seems apparent that valid studies on dehydration of corn must be made using samples for evaluation which have been rehydrated to the same extent, regardless of the time required for rehydration. In the strictest sense, even this type of comparison may be open to question if the rates of rehydration or the degree of curvature in the rehydration curves are widely variant. Another alternative might be to include in the design of the experiment, parameters believed to account for the effect of rehydration on the criteria of quality under consideration.

SUMMARY

Examination of rehydration characteristics of dehydrated corn has indicated that experimental treatments affect the rehydration rate of sweet corn. As a result, comparisons of quality must be made on samples all of which have been rehydrated to the same extent. Comparisons made on samples rehydrated by means of a constant temperature-time procedure will yield results in which the effects of treatments are confounded with the effects of rehydration.

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Technical Program and Abstracts

THIRTEENTH ANNUAL MEETING

OF THE

INSTITUTE OF FOOD TECHNOLOGISTS

•

JUNE 21-25, 1953

BOSTON, MASSACHUSETTS

YOUR ANNUAL MEETING

Every annual meeting of the Institute of Food Technologists is a new adventure in friendship, in scientific advancement, and in industrial development in the field to which we are responsibly committed—the improvement of the nation's food supply.

This year, Boston and the Northeast Section of the Institute extend traditional New England hospitality to all fellow members, their wives, and their children, who make the migration to the land of the bean and the cod. Equally heartily we welcome the exhibitors and their associates, without whom our meeting would be less fruitful and complete.

The chief professional objectives of these annual meetings are directed toward making America's foods more nutritious, more flavorful, safer, more attractive, and more convenient to use, and toward making the production of such foods more efficient through research and technological advancement. Certainly these are worthy goals, and every annual meeting provides opportunities for each of us to acquire new ideas which, in the months to come, we may translate in our various ways into "foods of the future."

In the fourteen years since our Institute was established, the stature of the food technologist has gained added recognition. It will continue to be enhanced as we endeavor to create and maintain new scientific advances to improve the quality and safety of foods in the American home.

The great increase in the manufacture and use of special foods in the American dietary—for the very young, the aged, and those with specific diet restrictions—is evidence of the added responsibilities with which our professional group of food technologists has been invested. Let us make every effort to demonstrate that we will be properly prepared to meet these requirements in the future, when the food research investigations of today will result in fundamental working tools to actuate new and better industrial food processes and the fabrication of improved food products for the better-fed and longer-lived race of super-men and women who will succeed us.

Our great Institute of Food Technologists had its inception in this area. Its first President is a "native son" and continues in his role as an active member of the Northeast Section, today's host. It is his hope and that of your present President that when this meeting is concluded, you will return home dedicated anew to the responsibilities of your important task in the service of the American public, better equipped to conduct those duties, and more eager to accomplish them successfully.

May your visit be such that you will look forward to other equally happy and profitable stays in Boston at some time in the future, and especially that you will look backward with satisfying memories of the people you met, the places you visited, and the scientific progress achieved during this meeting.

Sincerely,

BERNARD E. PROCTOR
President

TECHNICAL PROGRAM AND ABSTRACTS

SCHEDULE OF GENERAL AND SOCIAL EVENTS

(All events will be held in Hotel Statler unless otherwise noted.)

Saturday, June 20

Executive Council Meeting, 10 a. m.—Parlor E
Editorial Board Meeting, 7:30 p. m.—Parlor D

Sunday, June 21

National Council Meeting, 10 a. m.—Parlors D and E
Registration, 1:00 p. m.—Mezzanine
Informal Get-Together of Teachers of Food Technology, 8:00 p. m.—Room 406-408
Mixer, courtesy of Northeast Section, 8:30 p. m. —Ballroom

Monday, June 22

Section Officers' Breakfast, 7:30 a. m.—Parlor D
Registration, 8:30 a. m.—Mezzanine
Babcock and Food Engineering Awards Luncheon, 12:15 p. m.—Ballroom Assembly
Frozen Food Committee Meeting, 5:15 p. m.—Parlor D
Pops Concert, Boston Pops Orchestra, 8:30 p. m. —Symphony Hall (251 Huntington Avenue, Boston)

Tuesday, June 23

Massachusetts Institute of Technology Alumni Breakfast, 7:30 a. m.—Bay State Room
Registration, 8:30 a. m.—Mezzanine
University of Massachusetts Alumni Luncheon, 12:30 p. m.—Ballroom Assembly
Committee on Citrus Products, 5:15 p. m.—Parlor D
Packaging Institute Committee, 5:15 p. m.—Parlor E
Nicholas Appert Award Banquet, 7:00 p. m.—Ballroom (see Wednesday program for technical address)

Wednesday, June 24

Canadian Breakfast, 7:30 a. m.—Parlors D and E
Registration, 8:30 a. m.—Mezzanine
Business Meeting Luncheon, 12:30 p. m.—Ballroom Assembly
New England Clambake followed by Barn Dance, 6:30 p. m.—Rockwell Cage, Massachusetts Institute of Technology

Thursday, June 25

Plant Trips

Ladies' Program

Ladies' Lounge

There will be a lounge reserved for women guests of the IFT on the mezzanine of the Statler Hotel. Information on all events may be obtained there and all trips will assemble there. If you prefer independent sightseeing or shopping, suggestions for these tours will be available.

Complimentary Tickets

All special events listed below are offered free of charge to all women guests who have registered. Tickets will be available at the time of registration.

Sunday, June 21

3:00-5:00 p.m. Wives of the Council Members and the local committee are invited to tea at the home of Mrs. Bernard E. Proctor, 100 Memorial Drive, Cambridge.

Monday, June 22

9:00 a.m. Trip to the North Shore by sightseeing bus to Ipswich and Crane's Beach with the beautiful Crane Estate, returning through Rockport and Gloucester. Luncheon in Rockport, a picturesque artist's resort. Return to the Statler by 5:30 p. m.

Tuesday, June 23

2:00 p.m. Tour and tea at the Isabella Stewart Gardner Museum. Buses will leave the Statler at 1:45 p. m. and return about 5:00 p. m. Guided tour with a musicale and tea in the Grand Salon of this fascinating "palace."

Wednesday, June 24

10:00 a.m. Shopping tour by sightseeing bus to Chestnut Hill and Shopper's World. The bus will take you through Boston's suburban areas to these two beautiful new shopping centers where special events have been planned for you. You will have plenty of time to shop before returning to the Statler by 4:00 p. m.

Thursday, June 25

10:00 a.m. and 2:00 p.m. Ladies are welcome to tour the various plants which will be opened to IFT visitors.

SUMMARY OF TECHNICAL PROGRAM

Monday, June 22

10:00 a.m. General Session — Ballroom, Hotel Statler.

2:00 p.m. Section A Dietary Problems of an Aging Population — Ballroom.

2:00 p.m. Section B Research Papers: Meat Products — Room 406-8.

2:00 p.m. Section C Research Papers—Vegetable Products and Meats —Room 419.

Tuesday, June 23

9:00 a.m. Section D Research Papers—Quality Control—Room 406-8.

9:00 a.m. Section E Fish Processing — Bay State Room.

9:00 a.m. Section F Chemicals in Foods—Ballroom.

9:00 a.m. Section G Fermented Products — Room 419.

2:00 p.m. Section H Research Papers: Fruit Products — Room 406-8.

2:00 p.m. Section I Research Papers: Miscellaneous Studies — Room 419.

2:00 p.m. Section J Fish Processing — Ballroom.

Wednesday, June 24

9:00 a.m. Section K Research Papers: Microbiology—Room 419.

9:00 a.m. Section L Canning and Processing—Ballroom.

9:00 a.m. Section M Packaging Problems—Bay State Room.

9:00 a.m. Section N Fruit and Vegetable Research — Room 406-8.

11:20 a.m. General Session—Nicholas Appert Address—Ballroom.

2:00 p.m. Section O Canning and Processing—Ballroom.

2:00 p.m. Section P Fruit and Vegetable Research — Room 406-8.

DETAILED PROGRAM

MONDAY MORNING — JUNE 22

Ballroom, Hotel Statler

GENERAL SESSION

Chairman: PRESIDENT BERNARD E. PROCTOR

9:45 CALL TO ORDER.

9.50 GREETINGS FROM THE NORTHEAST SECTION, IFT, AND ANNOUNCEMENTS.
LOREN B. SJOSTROM, Chairman, Local Arrangements Committee.

10:00 PRESIDENTIAL ADDRESS: Food Frontiers.
BERNARD E. PROCTOR, Massachusetts Institute of Technology, Cambridge, Mass.

10:20 IN THE PUBLIC INTEREST.
DR. KARL T. COMPTON, Chairman of the Corporation, Massachusetts Institute of Technology, Cambridge, Mass.

11:00 The Ocean as a Potential Source of World Food Supply.
DR. G. A. REAY, Torry Research Station, Aberdeen, Scotlond.

11:45 **PRESENTATION OF CITATION TO SAMUEL CATE PRESCOTT, Founder and First President of the Institute of Food Technologists.**

MONDAY AFTERNOON — JUNE 22

Section A—Ballroom, Hotel Statler

Dietary Problems of an Aging Population

Chairman: CHARLES GLENN KING

2:00— 1. The Changing Age Pattern of the American Population, With Its Implications in the Field of Public Health.
W. H. SEBRELL, JR., M.D., National Institutes of Health.

2:30— 2. Guiding Principles for the Solution of Dietary Problems of an Aging Population.
CHARLES DAVIDSON, M.D., School of Medicine, Harvard University, Cambridge, Mass.

3:00— 3. Economic Adjustments That Have a Special Bearing Upon Food Supplies and Public Health.
JOHN D. BLACK, Ph.D., Harvard University, Cambridge, Mass.

3:30— 4. Obesity and Its Management As a Clinical Problem.
J. NORMAN JOLLIFFE, M.D., New York City Health Department, New York, N. Y.

4:00— 5. Trends in the Development of Foods for the Upper-Age Groups.

L. E. CLIFCORN, Continental Can Co., Chicago, Ill.

MONDAY AFTERNOON — JUNE 22

Section B—Room 406-8

Research Papers—Meat Products

Chairman: GEORGE GARNATZ

2:00— 6. Color Changes in Packaged Bologna.

A. A. KRAFT and JOHN C. AYRES, Iowa State College, Ames, Iowa.

2:20— 7. Antioxidant Treatment for Bacon.

JACK W. HANLEY, CHARLES W. EVERSON, LUCILLE Q. ASHWORTH, and ROY E. MORSE, Kingan and Co., Indianapolis, Ind.

2:40— 8. Observations on Fresh Meat Processed by the Infusion of Antibiotics.

H. H. WEISER, H. S. GOLDBERG, V. R. CAHILL, L. E. KUNKLE, and F. E. DEATHERAGE, The Ohio State Univ., Columbus, Ohio.

3:00— 9. Vascular Perfusion of Animal Parts.

KEVIN G. SHEA, IVAN S. MEYERS, MAURICE RARICK, and ROY E. MORSE, Kingan and Co., Indianapolis, Ind., and OSCAR E. SCHOTTE, Amherst College, Amherst, Mass.

3:20— 10. Effect of Low Freezer Storage Temperatures and Wrapping Materials on the Quality of Frozen Meats.

JEAN I. SIMPSON and IRENE C. I. CHANG, Syracuse Univ., Syracuse, N. Y.

3:40— 11. Low Temperature, High Speed Rendering.

W. R. DAYEN, KENNETH M. CHRISTENSEN, and ROY E. MORSE, Kingan and Co., Indianapolis, Ind.

4:00— 12. Factors Influencing Tenderness of Principal Muscles Composing the Poultry Carcass.

C. H. KOONZ, M. I. DARROW, and E. O. ESSARY, Swift and Company.

4:20— 13. Hog Immobilizing Process.

(*Food Engineering* Award Winner) L. W. MURPHY, Geo. A. Hormel and Co., Austin, Minn.

MONDAY AFTERNOON — JUNE 22

Section C—Room 419

Research Papers—Vegetable Products and Meats

Chairman: C. G. FERRARI

2:00— 14. Sampling Procedures for Grading of Tomatoes.

B. W. CLARKE, Crosse and Blackwell Co., Baltimore, Md., and AMIHUD KRAMER, Univ. of Maryland, College Park, Md.

2:20— 15. Effect of Application of Heat on Tomato Juice Color.

AMIHUD KRAMER and A. A. EL KATTAN, Univ. of Maryland, College Park, Md.

2:40— 16. Consistency Measurements of Tomato Puree (Pulp).

R. B. DAVIS, W. A. GOULD, DUANE DEWEESE, and GORDON L. PETERS, Ohio Agricultural Exp. Sta., Wooster, Ohio.

3:00— 17. Effect of Added Calcium Chloride and Sodium Hexametaphosphate (Calgon) on the Relative Viscosity and Pectin Content of Tomato Puree (Pulp).

GORDON L. PETERS, H. D. BROWN, W. A. GOULD, and R. B. DAVIS, Ohio Agricultural Exp. Sta., Wooster, Ohio.

3:20— 18. Measurement and Control of Odors from Tomato Cannery Waste Lagoons.

G. R. AMMERMAN and N. W. DESROSIER, Purdue Univ., Lafayette, Ind.

3:40— 19. Objective Procedures for Determining Grades of Raw, Canned, and Frozen Lima Beans.

W. J. HART, JR., John H. Dulany & Sons, Inc., Fruitland, Md., and A. KRAMER, Univ. of Maryland, College Park, Md.

4:00— 20. A Study of Rates of Freezing and Thawing Meats.

C. F. DUNKER and O. G. HANKINS, U. S. Dept. of Agriculture, Agricultural Research Center, Beltsville, Md.

4:15—20A. Composition and Quality of Commercially Cured Picnic Shoulders.

M. D. FIELDS, C. EDITH WEIR, and C. F. DUNKER, U. S. Dept. of Agriculture, Agricultural Research Center, Beltsville, Md.

4:30—20B. Variation in Tenderness in the Longissimus Dorsi Muscle of Pork.

C. EDITH WEIR, U. S. Dept. of Agriculture, Agricultural Research Center, Beltsville, Md.

TUESDAY MORNING — JUNE 23

Section D—Room 406-8

Research Papers—Quality Control

Chairman: E. E. LOCKHART

9:00— 21. Monosodium Glutamate and Food Preferences.

NORMAN F. GIRARDOT and DAVID R. PERYAM, Quartermaster Food and Container Institute, Chicago, Ill.

9:15— 22. Development and Application of Objective Methods for the Quality Evaluation of Capsicum Products.

HERBERT V. SHUSTER and E. E. LOCKHART, Dept. of Food Technology, Mass. Institute of Technology, Cambridge, Mass.

9:30— 23. Color Grading Foods with the Purdue Color Ratio Meter.

N. W. DESROSIER, Purdue Univ., Lafayette, Ind.

9:45— 24. Photometric Determination of Peroxide Value.

IRENE C. L. CHANG, Syracuse Univ., Syracuse, N. Y.

10:00— 25. The Sensory Panel as an Aid in Flavor Chemistry.

T. HASSELSTROM, Quartermaster Pioneering Research Laboratories, Philadelphia 45, Pa., and E. J. HEWITT, K. S. KONIGSBACHER, and W. H. DANKER, Evans Research and Development Corp., New York.

10:15— 26. Reliability of Taste Testing and Consumer Testing Methods.

ELSIE A. LAUE, ELAINE T. ZLOBIK, and NORMAN H. ISHLER, Central Laboratories, General Foods Corp., Hoboken, N. J.

10:30—26A. Approaches to the Panel Study of Food and the Need of Standardization.

DEAN FOSTER, United States Testing Co., Hoboken, N. J.

10:45— 27. A Study of Pilot Consumer Tests of Sucrose vs. Dextrose Monohydrate in Commercially Baked White Breads.

JEAN F. CAUL and W. A. RANZENBERGER, Arthur D. Little Inc., Cambridge, Mass.

11:00— 28. Comparison of Several Methods and Instruments for Specifying the Color of Frozen Strawberries.

J. SHAH and O. J. WORTHINGTON, Oregon State College, Corvallis, Ore.

11:15— 29. Formulation of Black Pepper Imitations.

T. HASSELSTROM, Quartermaster Pioneering Research Laboratories, Philadelphia 45, Pa., and E. J. HEWITT, J. J. RITTER, K. S. KONIGSBACHER, Evans Research and Development Corp., New York.

TUESDAY MORNING — JUNE 23

Section E—Bay State Room

Fish Processing

Chairman: H. L. A. TARR

9:00— 30. Ionizing Radiations for the Control of Fish Spoilage.

BERNARD E. PROCTOR and JOHN T. R. NICKERSON, Mass. Institute of Technology, Cambridge, Mass.

9:30— 31. Five-Pound Shrimp Packaging Tests.

ERNEST ADAMS, MARIAN KLEIN, and L. E. SIMERL, Marathon Corp., Menasha, Wis.

10:00— 32. Freezing Fish at Sea.

J. PUNCOCHAR, North Atlantic Technological Research, U. S. Fish and Wildlife Service, Boston, Mass.

10:30— 33. Is There an Alternative to Freezing Fish at Sea?

C. H. CASTELL, Fisheries Research Board of Canada, Halifax, Nova Scotia.

TUESDAY MORNING — JUNE 23

Section F—Ballroom

Chemicals in Foods

Chairman: CHARLES N. FREY

9:04— 34. A Plea for Standardization of Organoleptic Test Methods.

ELLY HINREINER, Dept. of Food Technology, Univ. of California, Davis, Calif.

9:26— 35. Progress Report on Work of the Food Protection Committee.

DAVID B. HAND, New York State Agricultural Exp. Sta., Geneva, N. Y.

9:48— 36. Public Education Regarding Chemicals in Foods.

W. A. KREHL and GEORGE R. COWGILL, Dept. of Nutrition, Yale Univ., New Haven, Conn.

10:10— 37. Medical Questions Concerning the Use of Chemical Additives to Food.

ELMER L. SEVRINGHAUS, M.D., Hoffmann-LaRoche, Inc., Nutley, N. J.

10:32— 38. Meeting the Dietary Requirements of Men, Insects, and Fungi in the United States.

GEORGE L. McNEW, Director, Boyce Thompson Institute for Plant Research, Yonkers 3, N. Y.

10:54— 39. Losses Occurring in Foods, and What Is Being Done About Them.

G. E. HILBERT, Bureau of Agricultural and Industrial Chemistry, U. S. Dept. of Agriculture, Washington, D. C.

11:16— 40. Status of Proposed Amendments Affecting Chemical Additives.

BERNARD L. OSER, Food Research Laboratories, Inc., Long Island City, N. Y.

11:38— 41. The Metabolic Versus the Toxicological Approach Toward Food Additives.

HARRY J. DEUEL, School of Medicine, Univ. of So. California, Los Angeles, Calif.

TUESDAY MORNING — JUNE 23

Section G—Room 419

Fermented Products

Chairman: F. W. FABIAN

9:00— 42. Thermal Inactivation of Pectolytic Enzymes in Genuine Dill Pickles.

W. B. ESSELEN and E. E. ANDERSON, Univ. of Massachusetts, Amherst, Mass.

9:20— 43. Varietal Differences in Cucumbers for Pickling.

I. D. JONES, J. L. ETCHELLS, and R. J. MONROE, No. Carolina Agricultural Exp. Sta. and Bureau of Agricultural and Industrial Chemistry, U. S. D. A., Raleigh, N. C.

9:40— 44. Sources and Types of Microorganisms Associated With the Softening of Fermenting Cucumbers.

J. H. LEVINSON and R. H. VAUGHN, Dept. of Food Technology, Univ. of California, Davis, Calif.

10:00— 45. Influence of Vinegar Eels *(Anguillula aceti)* on Vinegar Production.

RALPH C. ZALKAN and F. W. FABIAN, Dept. of Bacteriology and Public Health, Michigan State College, East Lansing, Mich.

10:20— 46. Fermentation of Sauerkraut as Affected by Salt and Temperature.

CARL S. PEDERSON and MARGARET N. ALBURY, N. Y. State Agricultural Exp. Sta., Geneva, N. Y.

10:40— 47. Factors Affecting the Quality of Cucumber Pickles.

A. H. JONES, G. S. HARPER, and W. R. PHILLIPS, Exp. Farms Service, Dept. of Agriculture, Ottawa, Canada.

11:00— 48. Influence of Gram-Negative Bacteria on the Sauerkraut Fermentation.

R. C. FULDE and F. W. FABIAN, Dept. of Bacteriology and Public Health, Michigan State College, East Lansing, Mich.

11:20— 49. Effect of Peroxidase Concentration, Acidity and Storage Temperatures on the Development of Off-Flavors in Fresh Pack Pickles.

M. D. LABBEE and W. B. ESSELEN, Univ. of Mass., Amherst, Mass.

11:40— 50. Fermentation of Green Tomatoes.

CARL S. PEDERSON and MARGARET N. ALBURY, N. Y. State Agricultural Exp. Sta., Geneva, N. Y.

TUESDAY AFTERNOON — JUNE 23

Section H—Room 406-8

Research Papers—Fruit Products

Chairman: W. H. COOK

2:00— 51. Observations on Dried Beverage Bases from Fruits.

S. A. EMODI, W. V. CRUESS, and KADRI RAMAZANOGUL, Univ. of California, Berkeley, Calif.

2:15— 52. Heat Induced Inhibitory Agents Obtained from Processed Fruits and Vegetables.

DOROTHY CULLER WILSON and H. D. BROWN, The Ohio State Univ., Columbus, Ohio.

2:30— 53. Storage Changes in Processed Apple Sauce.

G. E. LIVINGSTON, W. B. ESSELEN, and CARL R. FELLERS, Univ. of Massachusetts, Amherst, Mass.

2:45— 54. Pasteurization and Storage of Sweetened and Unsweetened Lime Juice.

OWEN W. BISSETT, M. K. VELDHUIS, and N. B. RUSHING, U. S. Citrus Products Sta., U. S. D. A., Winter Haven, Fla.

3:00— 55. Leach Pressing of Apples: A Method of Increasing the Yield of Full-Flavor Juice Concentrate.

G. W. MACPHERSON PHILLIPS, N. C. ACETO, and R. W. ESKEW, Eastern Regional Research Lab., U. S. D. A., Philadelphia, Pa.

3:15— 56. Grape Juice Powder.

R. K. ESKEW, H. I. SINNAMON, and V. A. TURKOT, Eastern Regional Research Lab., U. S. D. A., Philadelphia, Pa.

3:30— 57. Stabilization of Frozen Citrus Concentrates by Heat Treatment.

G. J. KELLER, R. G. RICE, R. J. McCOLLOCH, and E. A. BEAVENS, Fruit and Vegetable Chemistry Laboratory, U. S. D. A., Pasadena, Calif.

3:45— 58. Gelation and Clarification in Concentrated Citrus Juices. IV. Changes in Pectic Substances During Storage.

JAMES H. DIETZ, Florida Citrus Exp. Sta., Lake Alfred, Fla.

4:00— 59. Distribution of Pectinesterase and Total Pectin in Component Parts of Citrus Fruits.

A. H. ROUSE, Florida Citrus Exp. Sta., Lake Alfred, Fla.

4:15— 60. Sugar Hydrate Formations in Frozen Citrus Concentrates.

R. W. OLSEN and E. L. MOORE, Florida Citrus Exp. Sta., Lake Alfred, Fla.

4:30— 61. Copacker Quality Control with Particular Reference to Frozen Concentrated Citrus Juices.

A. D. D'ERCOLE and H. S. MADSEN, Birds Eye Division, General Foods Corp., Lakeland, Fla.

4:45—61A. Determination of Free Galacturonic Acid in Citrus Products.

V. V. ALMENDINGER, C. A. DILLMAN, and C. G. BEISEL, Research Dept., Real Gold Citrus Products, Anaheim, Calif.

5:00— 61B. Studies on the Processing of Red Cherries. III. A Comparison of Fruit from Different Geographical Regions.

CLAUDE H. HILLS and R. T. WHITTENBERGER, Eastern Regional Research Laboratory, Philadelphia 18, Pa.

TUESDAY AFTERNOON — JUNE 23

Section I—Room 419

Research Papers—Miscellaneous

Chairman: R. C. SHERWOOD

2:00— 62. Dehydrated Stabilized Egg. Importance and Determination of pH.

HAROLD SALWIN, I. BLOCH, and J. H. MITCHELL, JR., Quartermaster Food and Container Institute, Chicago, Ill.

2:15— 63. Influence of Lipids on Self-Dispersion and on Ease of Dispersibility of Whole Milk Powder.

W. K. STONE, T. F. CONLEY, and J. M. MCINTIRE, Quartermaster Food and Container Institute, Chicago, Ill.

2:30— 64. Calcium Removal from Fluid Milk by Ion Exchange.

R. D. COLEMAN, S. J. BISHOV, and J. H. MITCHELL, JR., Quartermaster Food and Container Institute, Chicago, Ill.

2:45— 65. Esters of Citric Acid in Stabilizing Edible Oils.

H. W. VAHLTEICH, C. M. GOODING, C. F. BROWN, and D. MELNICK, Research Laboratories, The Best Foods, Inc., Bayonne, N. J.

3:00— 66. Unsaturated Fat Oxidation Catalyzed by Hemin, Hemoglobin, and Cytochrome C.

A. L. TAPPEL and M. R. EMERSON, Univ. of California, Davis, Calif.

3:15— 67. Significance of the Browning Reaction in the Deterioration of Stored Grain.

C. E. MCDONALD and MAX MILNER, Kansas State College, Manhattan, Kan.

3:30— 68. Evaluation of Concurrent Feeding of Complementary Food Proteins to Man.

A. S. MELASPINA and R. S. HARRIS, Dept. of Food Technology, Mass. Institute of Technology, Cambridge, Mass.

3:45— 69. Comparative Nutritive Values of Mono-, Di-, and Triglycerides Fed at Equicaloric Levels in the Diets of Rats.

R. S. HARRIS and H. SHERMAN, Dept. of Food Technology, Mass. Institute of Technology, Cambridge, Mass.

4:00— 70. Phytates, Nutrition, and Food Processing.

R. S. HARRIS and FELIX BRONNER, Dept. of Food Technology, Mass. Institute of Technology, Cambridge, Mass.

4:20— 71. Crumb Softness from Soy Fractions.

C. W. OFELT, A. K. SMITH, and P. A. BELTER, Northern Research Lab., U. S. D. A., Peoria 5, Ill.

4:40— 72. Evaluation of the Flavor of Angel Cakes Prepared from Yeast Fermented and Enzyme Treated Dried Albumen.

AGNES FRANCES CARLIN, JOHN C. AYRES, and PAUL G. HOMEYER, Iowa Agricultural Exp. Sta., Ames, Iowa.

TUESDAY AFTERNOON — JUNE 23

Section J—Ballroom

Fish Processing

Chairman: W. F. HAMPTON

2:00— 73. A Comparison of Objective Tests for Quality of Gulf Shrimp.

E. A. FIEGER and J. J. FRILOUX, Dept. of Agricultural Chemistry and Biochemistry, Louisiana State Univ., Baton Rouge, La.

2:20— 74. Chemical Composition of Certain Species of Fresh-Water Fish.

M. E. STANSBY, U. S. Fish and Wildlife Service, Technological Laboratory, Seattle, Wash.

2:40— 75. Observations on the Canning of Pacific Coast or Dungeness Crabmeat.

LIONEL FARBER, George Williams Hooper Foundation, Univ. of California, San Francisco, Calif.

3:00— 76. Determination of Volatile Reducing Substances as an Aid in Quality Control of Canned Fish Such as Tuna.

LIONEL FARBER and ANNE CEDERQUIST, George Williams Hooper Foundation, Univ. of California, San Francisco, Calif.

3:20— 77. The Maillard Reaction in Flesh Foods with Special Reference to Fish.

H. L. A. TARR, Fisheries Experimental Sta., Vancouver, B. C.

3:40— 78. Armed Forces Research and Development Program for Seafoods.

S. R. PETERSON, Quartermaster Food and Container Institute, Chicago, Ill.

4:00— 79. Optical Density as a Measure of the Quality of Frozen Chinook Salmon.

H. O. A. OSMAN and O. J. WORTHINGTON, Oregan State College, Corvallis, Ore.

4:20— 80. Peruvian Tuna.

NORMAN JARVIS, College Park Lab., U. S. Fish and Wildlife Service, Maryland.

WEDNESDAY MORNING — JUNE 24

Section K—Room 419

Research Papers—Microbiology

Chairman: W. B. ESSELEN

9:00— 81. Sorbic Acid—A New Fungistatic Agent for Foods.

H. W. VAHLTEICH, The Best Foods, Inc., Bayonne, N. J.

9:05— 82. Harmlessness of Sorbic Acid as a Fungistatic Component of Foods.

H. J. DEUEL, JR. and R. ALFIN-SLATER, Univ. of So. California, Los Angeles, Calif.

9:25— 83. Fate of Sorbic Acid Applied to Cheese Wrappers.

D. MELNICK, F. H. LUCKMANN, and C. M. GOODING, The Best Foods, Inc., Bayonne, N. J.

9:40— 84. Need of the Cheese Industry for a Harmless Fungistatic Agent and the Value of Sorbic Acid Applied to Cheese Wrappers.

D. P. SMITH and N. ROLLIN, Milprint, Inc., West de Pere, Wis.

10:00— 85. Vitamin Synthesis of *Acetobacter xylinum.*

W. LITSKY and C. L. GOLDMAN, Univ. of Massachusetts, Amherst, Mass.

10:15— 86. A Colorimetric Method for Detection of Microbiological Spoilage in Citrus Juices.

E. C. HILL, F. W. WENZEL, and A. BARRETO, Florida Citrus Exp. Sta., Lake Alfred, Fla.

10:30— 87. Influence of Plant Hormones on Heat Resistant Bacterial Spores.

G. D. LABAW and N. W. DESROSIER, Purdue Univ., Lafayette, Ind.

10:45— 88. Observations on the Thermal Resistance of Putrefactive Anaerobe No. 3679 Spores in the Temperature Range of 250 to 300° F.

I. J. PFLUG and W. B. ESSELEN, Univ. of Massachusetts, Amherst, Mass.

11:00—88A. Determination of the Lethality of Baking and Cooking Procedures for the Destruction of Food Contaminating Microorganisms.

ARTHUR M. KAPLAN and HOWARD REYNOLDS, Bureau of Human Nutrition and Home Economics, U. S. D. A., Washington 25, D. C.

WEDNESDAY MORNING — JUNE 24

Section L—Ballroom

Canning and Processing

Chairman: E. J. CAMERON

9:00— 89. Continuous Heat Transfer and Processing in the Food Industry.

JOHN P. BOLANOWSKI, Girdler Corp., Louisville, Ky.

9:45— 90. Flavor Evaluation of Canned Cling Peaches.

SHERMAN LEONARD, BOR SHIUN LUH, and ELLY HINREINER, Univ. of California, Davis, Calif.

10:30— 91. Steam Blanching of Peas.

J. W. HOLMQUIST and L. E. CLIFCORN, Continental Can Co., Chicago, Ill.

WEDNESDAY MORNING — JUNE 24

General Session—Ballroom

Chairman: PRESIDENT BERNARD E. PROCTOR

11:20 NICHOLAS APPERT ADDRESS.
VICTOR CONQUEST, Armour and Company, Chicago, Ill.

WEDNESDAY MORNING — JUNE 24

Section M—Bay State Room

Packaging Problems

Chairman: L. W. ELDER

9:00— 92. New Saran Film Applications in Food Packaging.

F. J. GIBBS, Plastics Technical Service, The Dow Chemical Co., Midland, Mich.

9:25— 93. Influence of Nitrates in Foods on Tin Plate Corrosion.

N. H. STRODTZ and R. E. HENRY, Continental Can Co., Chicago, Ill.

9:50— 94. Some Recent Developments in Aluminum Foil Packaging of Food.

J. M. FULTZ, Development Laboratory, Reynolds Metals Co., Richmond, Va.

10:15— 95. The Eco Packaging System.

T. LOUIS JOHNSON, Alfred Hofmann and Co., West New York, N. J.

10:40— 96. A Non-destructive Method for Determining Microleakage in Commercial Glass Containers.

DAVE EOLKIN, Gerber Products Company, Oakland, Calif.

11:00—96A. A Practical Control Program for Shipping Containers.

F. BROWN, L. HAYHURST, and C. W. KAUFMAN, Kraft Foods Co., Chicago, Ill.

WEDNESDAY MORNING — JUNE 24

Section N—Room 406-8

Fruit and Vegetable Research

Chairman: J. R. WAGNER

9:00— 97. Dehydrated Green Beans.

EARL M. LITWILLER, Oregon State College, Corvallis, Ore.

9:20— 98. Effect of Processing Conditions on Moisture Retention by Dehydrated Peas and Snap Beans.

D. B. HAND, J. C. MOYER, and A. C. WAGENKNECHT, New York Agricultural Exp. Sta., Geneva, N. Y.

9:40— 99. Dehydration of Potato Granules by the Mixback Process.

A. N. COOLEY and D. E. SEVERSON, Univ. of North Dakota, Grand Forks, N. D.

10:00—100. Problems in the Add-Back Process for Production of Potato Granules.

G. H. NEEL, G. S. SMITH, M. W. COLE, R. L. OLSON, and W. O. HARRINGTON, Western Regional Research Laboratory, U. S. D. A., Albany, Calif.

10:20—101. Development and Evaluation of Potato Chip Bars.

R. H. TREADWAY, C. F. WOODWARD, and E. G. HEISLER, Eastern Regional Research Laboratory, Philadelphia, Pa.; and J. R. WAGNER and R. M. HOPKINS, Quartermaster Food and Container Institute, Chicago, Ill.

10:40—102. Influence of Piece Size on Production and Quality of Dehydrated Irish Potatoes.

M. SIMON, J. WAGNER, V. SILVEIRA, and C. E. HENDLE, Quartermaster Food and Container Institute, Chicago, Ill.; and Western Regional Research Laboratory, U. S. D. A., Albany, Calif.

11:00—103. Effect of Processing Variables on Storage Stability and Dehydrated Sweet Potatoes.

F. E. LINDQUIST, M. P. MASURE, W. C. DIETRICH, and MARVEL-DARE NUTTING, Western Regional Research Laboratory, U. S. D. A., Albany, Calif.

WEDNESDAY AFTERNOON — JUNE 24

Section O—Ballroom

Canning and Processing

Chairman: C. OLIN BALL

2:00—104. Processing Requirements for Canned Sterile Whole Milk.

W. J. BIEHL, International Milk Processors, Inc., Chicago, Ill.

2:45—105. Resistance of Bacterial Spores to Gamma Irradiation.

JAMES M. REED and BRUCE H. MORGAN, National Canners Assn., Research Lab., Washington, D. C.

3:30—106. Comparative Bactericidal Effects of Three Types of High-Energy Ionizing Radiations.

S. A. GOLDBLITH, B. E. PROCTOR, S. DAVISON, B. KAN, D. A. LANG, C. J. BATES, M. KAREL, and E. M. OBERLE, Mass. Institute of Technology, Cambridge, Mass.

4:15—107. Smith-Ball Pressure Canning Process.

HORACE L. SMITH, JR., Richmond 26, Va., and C. OLIN BALL, Rutgers Univ., New Brunswick, N. J.

WEDNESDAY AFTERNOON — JUNE 24

Section P—Room 406-8

Fruit and Vegetable Research

Chairman: M. A. COOLEY

2:00—108. Effect of Freezing, Sulphuring, and Storage Conditions on the Quality of Dehydrated Sweet Corn.

R. G. TISCHER and E. W. JERGER, Iowa State College, Ames, Iowa.

2:25—109. Studies on the Dehydration of Sweet Corn.

A. I. NELSON, L. L. KEMPE, H. W. NORTON, and L. B. HOWARD, Univ. of Illinois, Urbana, Ill.

2:50—110. In-Package Desiccation of Dehydrated Foods.

C. E. HENDLE, Western Regional Research Laboratory, U. S. D. A., Albany, Calif.

3:15—111. Stabilization of Dehydrated Cabbage by In-Package Desiccation.

H. K. BURR and V. SILVEIRA, Western Regional Research Laboratory, U. S. D. A., Albany, Calif.

3:40—112. Microbiology of Dehydrated Vegetables.

R. H. VAUGHN, Univ. of Cailfornia, Davis, Calif.

4:05—113. Dehydration of Clingstone Peaches.

M. MILLER, J. RECCA, J. KILBUCK, and E. M. MRAK, Univ. of California, Davis, Calif.

4:30—114. Production of Stable Dehydrated Orange Juice.

S. I. STRASHUN, ANN M. MYLNE, and W. F. TALBURT, Western Regional Research Laboratory, U. S. D. A., Albany, Calif.

ABSTRACTS

1. THE CHANGING AGE PATTERN OF THE AMERICAN POPULATION, WITH ITS IMPLICATIONS IN THE FIELD OF PUBLIC HEALTH

2. GUIDING PRINCIPLES FOR THE SOLUTION OF DIETARY PROBLEMS OF AN AGING POPULATION

3. ECONOMIC ADJUSTMENTS THAT HAVE A SPECIAL BEARING UPON FOOD SUPPLIES AND PUBLIC HEALTH

4. OBESITY AND ITS MANAGEMENT AS A CLINICAL PROBLEM

5. TRENDS IN THE DEVELOPMENT OF FOODS FOR THE UPPERAGE GROUPS

6. COLOR CHANGES IN PACKAGED BOLOGNA

A. A. KRAFT and JOHN C. AYRES, Department of Bacteriology, Iowa State College, Ames, Iowa.

Discoloration of sliced large bologna was studied by means of reflectance measurements and by subjective evaluation. Scores for good and for poor control samples were assigned according to values obtained for the ratio of spectral reflectance at wavelengths 650 and 570 mμ, a ratio proposed by Ramsbottom *et al.* as an index of color fading. The scoring system was employed to evaluate the effects of packaging materials, display-case lighting, and vacuum packaging on color retention in bologna.

The ratio of reflectance at 650 mμ to that at 570 mμ appeared to correlate with the judges' scores during storage periods varying from one to three days, but depended upon the packaging material used. Materials of high permeability to moisture vapor permitted browning and darkening of the meat surface due to dehydration. Under these conditions, the direct relationship between visual evaluation and the reflectance ratio no longer held. On the other hand, values for total reflectance at wavelengths from 540 to 800 mμ provided a more constant relation to estimates of color given by the judges throughout a storage period of one week.

Comparison of reflectance curves with the color scores of a panel of judges indicated the possibility that an index might be derived for predicting the storage life of packaged bologna with regard to changes in color.

7. ANTIOXIDANT TREATMENT FOR BACON

J. W. HANLEY, C. W. EVERSON, L. Q. ASHWORTH, and R. E. MORSE, Research Laboratories, Kingan & Co., Indianapolis, Indiana.

Determinations have been made of the extent of fat stabilization provided by various antioxidants when injected into bacon bellies or when applied as a coating to the surface. Hydroquinone, butylated hydroxy anisole, propyl gallate and citric acid were used separately and in various combinations. Samples of treated bacon were sliced, packaged, and stored at 0 ° and 28 ° F. until deterioration was apparent. Evaluations of rancidity development as performed by a trained taste panel did not correlate with chemical criteria. Dipped coatings containing 5 and 10% butylated hydroxy anisole in pure lard gave markedly increased fat stability. Similar results were achieved by injection of acqueous solutions containing 0.2% hydroquinone or 0.2% butylated hydroxy anisole. The distribution of antioxidant between fat and lean in raw bacon and between fat, lean and cooked-out grease in fried bacon was determined by the dipyridyl and dichloroquinone chlorimide methods. With uncooked bacon results indicated that butylated hydroxy anisole is preferentially concentrated in the fat phase. With cooked bacon a similar distribution was observed; however, in cooking, 20% of the antioxidant is destroyed. Although somewhat higher values were obtained with the dipyridyl method, both analytical procedures gave proportional results for antioxidant distribution.

8. OBSERVATIONS ON FRESH MEAT PROCESSED BY THE INFUSION OF ANTIBIOTICS

H. H. WEISER, H. S. GOLDBERG, V. R. CAHILL, L. E. KUNKLE and F. E. DEATHERAGE, Departments of Bacteriology, Animal Science, and Agricultural Biochemistry, The Ohio State University and The Ohio Agricultural Experiment Station, Columbus, Ohio

Processing of fresh meat may be limited by the initial refrigeration required to prevent internal spoilage (sours). Studies on the bacterial populations in the muscle, lymph nodes and bone marrow of beef and on the effect of retarding spoilage in ground beef by the use of antibiotics indicated that beef might be held without immediate refrigeration if processed by infusion of antibiotics. Twenty-three paired rounds and 8 whole animals were infused with saline containing aureomycin so as to put approximately 2 p.p.m. of the antibiotic into the meat. Aureomycin was determined in the meat at various times after slaughter and after 72 hours post mortem all antibiotic had disappeared. Non-infused mated rounds contained more organisms than infused rounds when both were refrigerated. When refrigeration was delayed 48 to 72 hours post mortem, a majority of the control rounds soured whereas the infused rounds remained in good condition. When whole animals were infused and dressed out, no sides spoiled even though held out of refrigeration for 48 hours. The non-refrigerated side was more tender than the refrigerated side. No flavor differences were induced by the infusion. Some color improvement was noted in the non-refrigerated side.

9. VASCULAR PERFUSION OF ANIMAL PARTS

K. G. SHEA, I. S. MEYERS, M. RARICK and R. E. MORSE, Research Laboratories, Kingan and Co., Indianapolis, Indiana, and O. E. SCHOTTE, Department of Biology, Amherst College, Amherst, Massachusetts.

Among the attributes of high quality beef muscle is a characteristic known as marbling which is generally associated with tenderness and flavor. Currently these effects are achieved through a high caloric intake in feedlots. This process is inefficient and results in undesired fat depots outside the muscular tissue. This paper presents an improved technique for the induction of marbling by mechanically introducing fat into the vascular system of beef. Results are described for the injection of modified whole carcasses, rounds and loins. Owing largely to vascular damage caused by standard packing house practices, uniform results were not obtained with whole carcasses and loins. As evaluated on the visual criteria of over-all fat distribution and marbling best results are achieved with rounds. These studies failed to reveal a marked improvement in flavor or tenderness following injection.

10. EFFECT OF LOW FREEZER STORAGE TEMPERATURES AND WRAPPING MATERIALS ON THE QUALITY OF FROZEN MEATS

JEAN I. SIMPSON and IRENE C. L. CHANG, College of Home Economics, Syracuse University, Syracuse, N. Y.

This study compares the keeping quality of hamburg, bacon and sausage at the usual home-freezer temperature (0° F.) with samples stored at lower temperatures (−20°, −30°, and −40° F.). At intervals during freezer storage, samples were compared as to development of rancidity (peroxide determination), as to flavor changes (organoleptic tests), and as to moisture loss. By lowering freezer storage temperature, the development of rancidity was found to be retarded. However, the hamburg in this study did not show significant rancidity until it had been stored for more than 1½ years at 0° F.

Aluminum foil and glassine-laminated paper both retarded the development of rancidity of each kind of meat at each storage temperature when compared with samples wrapped in polyethylene-coated paper and in butcher-wrap of high quality. Little difference, as regards the development of rancidity, was found between meats in the 2 latter wrapping materials. Results of organoleptic tests agreed, in general, with the results of peroxide determinations.

Moisture loss was insignificant at any storage temperature when aluminum foil, polyethylene-coated paper, or glassine-

laminated paper was used. The samples in butcher-wrap showed rapid loss of moisture at 0° F., but decided protection was noted when the storage temperature was −20° F. or lower.

11. LOW TEMPERATURE, HIGH SPEED RENDERING—THE KINGAN PROCESS

W. R. DAYEN, K. M. CHRISTENSEN and R. E. MORSE, Research Laboratories, Kingan and Co., Indianapolis, Indiana.

The Kingan Flash Rendering Process is based on the release of oil from tissue through comminution to cellular dimensions. Comminution is performed at a temperature of approximately 140° F. Separation of the oil from the tissue solids and water is accomplished by centrifugation. The characteristics and operating conditions of the equipment in the processing of beef or pork fat are described together with the factors which must be considered in the design of large-capacity rendering systems. The process has been found to improve both quality and yield of animal fats. In addition the process reduces manpower and floor space requirements, and lowers both operating and capitalization costs. Experimental evidence indicates that this rendering process is applicable to vegetable and marine oils.

12. FACTORS INFLUENCING TENDERNESS OF PRINCIPAL MUSCLES COMPOSING THE POULTRY CARCASS

C. H. KOONTZ, M. I. DARROW, and E. O. ESSARY
Swift and Company

Tenderness of poultry is dependent upon antemortem and postmortem influences. Antemortem factors affecting tenderness of muscles include age, breed, and management of bird. Postmortem factors affecting tenderness include those that appear to be related to the state of rigor. Time and temperature of holding which regulate enzyme activity also influence tenderness. The present paper is concerned primarily with demonstrating the normal tenderness pattern of the principal poultry muscles during the early postmortem period and with attempts to alter the pattern of the various muscles during this period. It was found, under what appeared to be conventional methods of handling, that the less tender condition—which may be associated with the state of rigor—disappeared in general within 8 hours after birds were dispatched. It was shown to be possible under experimental conditions to alter the tenderness pattern for various muscles.

13. HOG IMMOBILIZING PROCESS (WINNER OF FOOD ENGINEERING AWARD)

L. W. MURPHY, Service Division, Geo. A. Hormel & Co., Austin, Minnesota

Carbon dioxide has been used successfully to immobilize live hogs before shackling and sticking at a rate of 1100 animals per hour in a continuous operation.

While developed to ease the most violent unit operation in food manufacturing, the technique has several additional benefits which contribute to its importance.

Immobilizing greatly diminishes animal fatigue and thus contributes to better meat quality.

It reduces the amount of dirt on the animals and workers, assures more accurate sticking, and reduces blood spattering.

It increases animal respiration and therefore improves blood recovery.

It permits uniform rail speed in pace with other plant operations and contributes to plant efficiency.

It reduces the amount of labor involved in the shackling operation.

Carbon dioxide is administered in controlled quantities in a tunnel through which the animals are moved. In a matter of seconds, the hog settles into a quiet "sleep" on a stainless steel conveyor in the tunnel, ready for easy shackling and subsequent sticking.

A colored movie will show the process in actual operation.

14. SAMPLING PROCEDURES FOR GRADING OF TOMATOES

B. W. CLARKE, Crosse and Blackwell Co., Baltimore, Md. and AMIHUD KRAMER, University of Maryland, College Park, Maryland

A procedure is described for determining how many tomatoes out of how many baskets constitute the most efficient sample for grading purposes. The results indicate that 10 tomatoes out of 10 baskets (or a multiple thereof, depending on the precision required) constitute the most economical sample. The same procedure is applicable to similar problems with other products transported in containers rather than in bulk.

15. EFFECT OF APPLICATION OF HEAT ON TOMATO JUICE COLOR

AMIHUD KRAMER and A. A. EL KATTAN, University of Maryland, College Park, Maryland

The extent of color loss resulting from the application of heat to tomato juice was found to proceed in accordance with the equation:

$$\text{Color loss} = \log \frac{Ts}{525}\left(\frac{RT - 120}{40}\right)$$

where color loss is in terms of the U. S. grading system as determined by the Hunter color difference meter, Ts is temperature summation in terms of degrees above 140 ° F. times seconds, and RT is the retort temperature.

16. CONSISTENCY MEASUREMENTS OF TOMATO PUREE (PULP)

REES. B. DAVIS, W. A. GOULD, DUANE DEWEESE, and GORDON L. PETERS, The Ohio Agricultural Experiment Station, Wooster, Ohio

Tomato pulp was manufactured by the "hot break" and the "cold break" processes. Consistency was measured by using the Bostwick consistometer, Adams consistometer, Stormer Viscosimeter, Gardner Mobilometer and the Blotter Test. Correlations and data are presented to show that consistency must be measured in terms of "flow" and viscosity.

17. EFFECT OF ADDED CALCIUM CHLORIDE AND SODIUM HEXAMETAPHOSPHATE (CALGON) ON THE RELATIVE VISCOSITY AND PECTIN CONTENT OF TOMATO PUREE (PULP)

GORDON L. PETERS, H. D. BROWN, W. A. GOULD, and REES B. DAVIS, The Ohio Agricultural Experiment Station, Wooster, Ohio

Tomato pulp of known quality was manufactured by the "hot break" and "cold break" processes. Sodium hexametaphosphate and calcium chloride were added to lots manufactured by each process. The pectic constituents of the manufactured purée and the relative viscosity (Ostwald-Fenske Viscosimeter) of the tomato serum were determined. Data are presented to show that sodium hexametaphosphate, added calcium chloride and the different processes have a direct effect on the pectic constituents and the relative viscosity.

18. MEASUREMENT AND CONTROL OF ODORS FROM TOMATO CANNERY WASTE LAGOONS

G. R. AMMERMAN and N. W. DESROSIER, Purdue University, Lafayette, Indiana

The control of odor in tomato cannery waste was studied, using the stinkometer as a means of objectively measuring odor intensity. Bacteriological and organoleptical examinations were also made.

Materials used in the study were as follows: (1) an orthodichlorobenzene compound: (2) an essential oil preparation: (3) sodium nitrate: (4) aëration.

It was found that air would give nearly perfect control of odor when passed through waste at the rate of 1 liter per 2 minutes for every 10 liters of waste containing approximately 1,000 p.p.m. total solids.

Of the commercial preparations tested, the orthodichloro benzene preparation was most effective, followed by the essential oil preparation and sodium nitrate.

19. OBJECTIVE PROCEDURES FOR DETERMINING GRADES OF RAW, CANNED, AND FROZEN LIMA BEANS

W. J. HART, JR., John H. Dulany & Son, Fruitland, Maryland, and AMIHUD KRAMER, University of Maryland, College Park, Maryland

A procedure is proposed, based on three years' results, including sampling by the use of an automatic sampling device, trash deduction, determined by means of specially constructed equipment, and a maturity test by the use of the shearpress for the raw product. For the processed material, the use of alcohol insoluble solids is discussed as well as other methods based on specific gravity and on color, including instrumental methods.

20. A STUDY OF FREEZING AND THAWING MEATS

C. F. DUNKER and O. G. HANKINS, Bureau of Animal Industry, Agricultural Research Administration, United States Department of Agriculture, Beltsville, Maryland

Tests were carried out to obtain information on rates of freezing and thawing of ground meat, of whole pieces of meat of various sizes, and of meats having low and high percentages of fat.

Six-inch cubes of lean ground pork were frozen in air blast, in still air and by contact in plate freezers at minus 70° F. and at +5° F. Thermocouples were inserted 0.5; 1.0; 2.0; and 3.0 inches from the outer face of the meat cubes. The latter thermocouple was in the exact center of the meat. After temperatures throughout the meat and surrounding air temperatures were coincident, the samples were thawed at 40° F. Freezing tests were repeated and the samples were thawed at +70° F. and finally at +90° F. Samples frozen and thawed included ground lean beef, ground lean and fat pork, and lean pieces of unground pork. In addition to 6-inch cubes, rectangles 6 x 6 x 3 inches were tested.

All temperature recordings were made on two 16-point automatic recording potentiometers. Each machine recorded its 16 temperatures every 1.5 minutes.

There are many practical applications of the results, which are discussed in detail.

20A. COMPOSITION AND QUALITY OF COMMERCIALLY CURED PICNIC SHOULDERS

M. D. FIELDS, C. EDITH WEIR and C. F. DUNKER, Bureau of Animal Industry, Agricultural Research Administration, United States Department of Agriculture, Beltsville, Md.

Results of a survey of commercial curing methods used in producing cured picnics showed that there are four typical methods: (1) sweet pickle, quick-cured, tendered, (2) sweet pickle, quick cured, ready-to-eat, (3) sweet pickle, long cured, and (4) the dry-cured Smithfield process.

In general, the brine-cured picnics showed similar chemical composition, whereas the Smithfield picnics were much lower in moisture and showed greater fat and protein hydrolysis.

Organoleptic tests showed all picnics had an overall rating of "good."

The biological values of the protein, for the most part, were approximately the same.

Vitamins B_1, G_2, and niacin content of the picnics and shoulders showed them to be very good sources of these vitamins.

Bacteriologically, most picnics showed no count or had insignificant numbers of bacteria.

20B. VARIATION IN TENDERNESS OF THE LONGISSIMUS DORSI MUSCLE IN PORK

C. EDITH WEIR, Bureau of Animal Industry, Agricultural Research Administration, United States Department of Agriculture, Beltsville, Maryland

This report deals with the differences in tenderness found throughout the length of individual pork loins. The significance of these differences, in relation to the interpretation of tenderness data obtained from pork loins by mechanical shearing and organoleptic tests, is discussed.

Mechanical shearing tests indicate the longissimus dorsi muscle becomes more tender toward the anterior end. The difference was not apparent to an experienced organoleptic panel using a scoring system for rating tenderness.

21. MONOSODIUM GLUTAMATE AND FOOD PREFERENCES

NORMAN F. GIRARDOT and DAVID R. PERYAM, Quartermaster Food and Container Institute, Chicago, Illinois

The effect of monosodium glutamate on food preferences was studied in 50 foods and recipes including fresh, canned and dehydrated vegetables, fresh and canned meats, fish, soups, fruit juices, and various meats and vegetable recipes from the Army cook-book. Difference testing by a trained panel guided the selection of MSG concentrations to assure that all preference tests involved detectable flavor differences. Preference testing was by the method of paired comparisons. Control foods were compared with the same foods containing known concentrations of MSG. All participants in the preference tests were consumer-observers randomly selected from personnel of the Chicago Quartermaster Depot.

Monosodium glutamate was found to improve preference significantly for 25 of the 50 foods. Although the frequency and extent of improvement in preference was greatest for fish, canned meats, canned vegetables, and meat recipes, no "class" of foods was found to be improved without exception. The concentrations recommended in many published recipes had to be increased substantially to improve preference. Sweet foods in general failed to show improvement but no other trends related to flavor type were found.

22. DEVELOPMENT AND APPLICATION OF OBJECTIVE METHODS FOR THE QUALITY EVALUATION OF CAPSICUM PRODUCTS

HERBERT V. SHUSTER and E. E. LOCKHART, Department of Food Technology, Massachusetts Institute of Technology, Cambridge, Massachusetts

Visible transmittance curves of acetone extracts of capsicums, whatever their origin, are quite similar and exhibit a plateau-like maximum absorbancy 18 mμ in width with a center at 462 mμ.

A technique was developed for extraction of maximum carotenoid pigment from the spice by macerations with acetone. Extraction rates were dependent upon time, temperature, and particle size. Acetone extracts conformed with Beer's Law within the range studied.

Spectrophotometric absorbencies of extracts at 462 mμ correlated significantly with visual scores and with Lovibond Red values of ethanolic extracts. Color evaluation of paprika spice by either abridged spectrophotometry or filter photometry was found to be more precise and reproducible than by the Lovibond technique.

The visible spectra of acetone solutions of oleoresins paprika and capsicum are essentially identical. The photometric technique developed for paprika spice can be used to evaluate the color quality of these oleoresins more simply and precisely than is possible by comparison against cobalt-dichromate solutions.

23. COLOR GRADING FOODS WITH THE PURDUE COLOR RATIO METER

N. W. DESROSIER, Purdue University, Lafayette, Indiana

An inexpensive, easily operated, rugged, color-grading instrument has been developed for red foods such as apples, tomatoes, tomato products and several small fruit products. The instrument and its applications are discussed.

24. PHOTOMETRIC DETERMINATION OF PEROXIDE VALUE

IRENE C. L. CHANG, Syracuse University, Syracuse, New York

A microtechnique using photoelectric colorimeter for the determination of peroxide value in fats or oils has been developed. The procedure still involved the liberation of iodine from potassium iodide by the peroxide oxygen present in oxidized fats, but instead of titrating a two-phase solution with sodium thiosulphate after adding water to the reaction mixture (as in the classical titration method), the liberated iodine was determined photometrically. This improvement increased both the sensitivity and the accuracy of the method. Furthermore, due to the elimination of titration procedure, it was also possible to avoid oxygen error by carrying out the determination under inert atmosphere. This finding is of particular interest in making de-

terminations in samples of very low peroxide content, since the oxygen error becomes more important at lower values of peroxide. It should also be mentioned that the new method is simple and requires no special apparatus except a photoelectric colorimeter, which is found in most food research laboratories.

25. THE SENSORY PANEL AS AN AID IN FLAVOR CHEMISTRY

T. HASSELSTROM, Quartermaster Pioneering Research Laboratories, Philadelphia 45, Pa., and E. J. HEWITT, K. S. KONIGSBACHER, and W. H. DANKER, Evans Research and Development Corporation, New York, N. Y.

Twelve members of a sensory panel were trained to give similar responses to the same stimulus. Specifically, the value of a panel in the preparation of imitation black peppers was determined. A standard pepper was rated on a list of twelve characteristics which had been established by more promising imitations then were rated according to the presence of each characteristic note. Separation of odor elements from natural pepper oil by fractional distillation and by chromatography was followed by sensory testing. The data obtained by olfactory testing then were used as a guide for the formulation of imitation black peppers. The imitations were evaluated according to the similarity of characteristic notes to those of the natural product. In this manner a reasonable improvement in quality was observed from one series of imitations to the next.

By this admittedly rough estimate of the quality of imitations and natural black peppers the following characteristics were found to be most difficult to imitate: "true pepper odor", spiciness, and sharpness.

Evidence was obtained that the use of a sensory panel in this manner often served the same purpose as a lengthier chemical investigation since the isolation of flavor elements and their evaluation by the panel sufficed to guide the preparation of imitation black peppers.

26. RELIABILITY OF TASTE TESTING AND CONSUMER TESTING METHODS

ELSIE A. LAUE, ELAINE T. ZLOBIK, and NORMAN H. ISHLER, Central Laboratories Division, General Foods Corporation, Hoboken, New Jersey

The influence of fatigue has been measured during routine taste testing of coffee and maple syrup. Methods and results are described.

Effect of code bias in consumer testing has also been measured under actual testing conditions. The danger of obtaining misleading results is shown, and a remedy suggested.

The performance of a trained laboratory panel is described with respect to its ability to find differences large enough to result in important consumer preferences. The approximate equivalent effectiveness of expert and consumer panels is derived from the data presented.

26A. APPROACHES TO THE PANEL STUDY OF FOODS AND THE NEED FOR STANDARDIZATION

DEAN FOSTER, United States Testing Company, Hoboken, New Jersey

Standardization is needed in all phases of consumer panel testing. At present, a wide variety of techniques are used, each devised to resolve a particular problem. It is essential to develop a number of techniques that will have wide application, yet form a basis for comparison regardless of application through standardization of test procedures. Such standardization is necessary if consumer panel testing is to have as its foundation the validity upon which the physical sciences are based. Without standardization we are the four blind men examining the elephant, each a "specialist" in his own area, but one area having no relation to another. In order for the manufacturer of food products to control his operations, it is essential that this question be resolved. In order for panel testing to adopt the refinements and sophistication which exist in our present day physical sciences, it is necessary that this standardization and reproducibility of test data be achieved and formalized. This paper is concerned with tentative standards to achieve this goal.

27. A STUDY OF PILOT CONSUMER TESTS OF SUCROSE VS. DEXTROSE MONOHYDRATE IN COMMERCIALLY BAKED WHITE BREADS

JEAN F. CAUL, Arthur D. Little, Inc., Cambridge, Mass., and W. A. RANZENBERGER, Lahr Advertising Agency, Inc., Indianapolis, Indiana

The objective of this study was to obtain information pertaining to certain flavor questions regarding the competitive positions of sucrose and commercial dextrose. Sets of white bread for subsequent testing were baked, using basic formulas that differed only in type and quantity of sweetener. Consumer acceptance of these breads was measured by paired comparison tests which emphasized preference expressions and sweetness discriminations. In addition, flavor characteristics of the breads were compared by Flavor Profile. Findings were presented for bakes whose formulas were practically of equal cost or equal sweetness.

28. COMPARISON OF SEVERAL METHODS AND INSTRUMENTS FOR SPECIFYING THE COLOR OF FROZEN STRAWBERRIES

J. SHAH and O. J. WORTHINGTON, Oregon State College, Corvallis, Oregon

In PMA grade standards for frozen strawberries color accounts for 40% of the total score, besides being a "stopper" or critical factor. Subjective estimates are the only ones used at present, since only one objective method for strawberries has been published and it is a chemical analytical method for pigment concentration. Therefore the need for physical color determination methods is particularly urgent with this commodity. The instruments compared here are the Hunter Color Difference Meter, the Photovolt Reflectionmeter Model 610, and the Beckman DU Spectrophotometer used as an absorptometer.

The Marshall variety is particularly reported here. Sixty samples were examined by at least 2 instruments in each of 2 years. After determining the best method of presentation of the sample to the instrument this method was used as standard. Several criteria were studied for each instrument in order to determine the best method for that instrument. For instance, in the case of the Hunter C. D. meter, it is desirable to know whether one must use all 3 factors (L, a_L and b_L) to specify strawberry color adequately or if one factor alone or a combination of 2 factors may be used. This is answered by two statistical methods: the magnitude of the correlation coefficients against visual color scores and analysis of variance of the slopes of the regression lines.

All instruments yield at least one method with R^2 or r^2 greater than 0.8 showing that one instrument is not irrefutably better than another but that one's choice is determined by many factors, the method of using the instrument being one factor to which the data are pertinent. Correlation coefficients between instruments show the possibilities in substituting one instrument for another. Indicative of the further application of one of the methods is the fact that the r^2 of the Hunter L against visual scoring for 218 samples of 12 varieties is 0.936.

29. FORMULATION OF BLACK PEPPER IMITATIONS

T. HASSELSTROM, Quartermaster Pioneering Research Laboratories, Philadelphia 45, Pa., and J. J. RITTER and K. S. KONIGSBACHER, Evans Research and Development Corporation, New York, N. Y.

Natural black pepper is composed of a flavor principle—the essential oil—that gives pepper its aroma, a pungent principle that provides the bite, and a carrier principle consisting of the oleoresin and inert fillers which act as fixatives and dispersing agents.

The first step in the formulation of an imitation black pepper was the analytical investigation of the natural product. From the essential oil a number of odor elements and components were isolated by distillation and chromatography. Some of these were identified as: γ-Pinene, β-pinene, γ-phellandrene, limonene, caryophyllene, caryophyllene oxide, dihydrocarveol, piperonal, cryptone, and piperidine. Pungents were isolated from the oleoresin which then was separated into acidic, basic, and neutral portions. The pungent and carrier principles were examined in a preliminary manner.

Black pepper imitations were formulated, based on the above data. The synthetic essential oil aroma principle was prepared by simulating or duplicating the odor elements isolated and the components identified in a natural oil making use of domestic raw materials only. The pungents were prepared synthetically based on research conducted by the Germans during the last war. No attempt was made to imitate the oleoresin of natural black pepper; a substitute was prepared from a mixture of natural plant materials and synthetic resins. Potato peels, Trader's Base, Larrowe's Base, corn cobs, cereals, and other materials have been tried as fillers.

The art of compounding the various ingredients was found to play an important role in the stability and acceptability of the immitation pepper. A method of stepwise combination of components was developed.

The natural black peppers and the imitations prepared in our laboratories were evaluated by a trained sensory panel.

30. IONIZING RADIATIONS FOR THE CONTROL OF FISH SPOILAGE

BERNARD E. PROCTOR and JOHN T. R. NICKERSON,
Department of Food Technology, Massachusetts Institute of Technology, Cambridge, Mass.

Fish and fish fillets are subject, in general, to 3 types of deteriorative changes, one of which is decomposition caused by microörganisms. This decomposition results almost entirely from bacterial action, and the types of organisms that grow on fish are usually found in highest concentration on surface tissues. A study was made of the effect of ionizing radiations on the control of fish spoilage caused by surface bacteria. Fish fillets were irradiated with supervoltage cathode rays at levels sufficient to destroy non-spore-forming surface bacteria and were then stored at refrigerator temperatures. Bacterial counts were made on samples of the fillets before and after irradiation and after storage. The possibility of using ionizing radiations to reduce the number of surface organisms on fish (a heat-labile material) without heat sterilization—cathode ray irradiation results in no production of heat—is discussed from the standpoint of extending the storage life of refrigerated (non-frozen) fish.

31. FIVE-POUND SHRIMP PACKAGING TESTS

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The tests described were conducted to determine a suitable method for packing frozen shrimp. Five-pound packages of headed, unpeeled raw shrimp were filled under commercial conditions, using two types of cartons with improved construction, and the present commercial stapled cartons. The variations included glazed and unglazed shrimp, without overwrap, and with overwraps of cellophane and Tyton frozen food overwrap. The packaging was done in New Orleans with white shrimp, and at Brownsville, Texas with brown shrimp. This report covers the test results after 12 months' storage at 0° F.

Results indicate that unglazed shrimp in packages with an overwrap showed negligible weight loss and were in excellent condition. On blindfold taste tests, a special panel was unable to distinguish between glazed and unglazed shrimp packaged with an overwrap. It is concluded that the glazing operation is unnecessary if the carton has a satisfactory overwrap. The glazed shrimp packages, without an overwrap, showed high weight losses, evaporation of the ice glaze, considerable dessication of the surface shrimp, and slight increase in toughness.

32. FREEZING FISH AT SEA

J. F. PUNCOCHAR and S. R. POTTINGER, U. S. Fish and Wildlife Service, Boston, Massachusetts

The U. S. Fish and Wildlife Service's freezing-fish-at-sea program is reviewed. The review includes results of experiments on East and West Coast species of fish, freezing and thawing rates for fish frozen in sodium chloride brine and thawed in tap water, semi-commercial-scale processing of brine-frozen haddock, palatability tests, and a description of recent innovations on the experimental trawler *Delaware*. Some results of freezing-fish-at-sea experiments in British Columbia and Great Britain are discussed.

33. IS THERE AN ALTERNATIVE TO FREEZING FISH AT SEA?

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From a theoretical standpoint, freezing at sea is the best available method for preserving the quality in fresh fish. In many cases freezing at sea may not be economically feasible; and there is also the fact that a large group of our consumers still have a preference for unfrozen fish.

This paper outlines recent work to determine whether it is possible by greater care in handling fish at sea to land fish of a quality that is comparable to sea-frozen fish at the time it is landed.

The quality of the fish is followed from the time it is caught until it is landed at the wharf in an attempt to find out what are chief contributing factors bringing about deterioration of the fish in the boats at sea. This includes prolonged exposure of the fish on the deck, careless or improper gutting and washing, bruising and crushing the fish, the use of dirty ice, dirty fish holds and the proper distribution of ice in the hold.

This work is part of a larger survey of factors affecting quality in fresh fish, which has not yet been completed. But on the basis of data so far obtained, recommendations can be made that will greatly improve the quality of fish from our present vessels.

34. A PLEA FOR STANDARDIZATION OF ORGANOLEPTIC TEST METHODS

ELLY HINREINER, Department of Food Technology, University of California

Although it may be argued that as yet too little is known about the myriad factors involved in organoleptic analysis of foods to permit the adoption of standardized, uniform techniques, the advantages of such standardization would almost certainly outweigh the disadvantages. Specific agreement on statistical designs, sampling, training and selection of panels, methods of preparation and serving, scoring, and tasting environment would make possible direct comparisons of the results of many different laboratories engaged in similar projects, and would obviate much duplication of work.

Adoption of a standard method or methods for routine organoleptic tests does not imply that the best possible techniques have been developed and are already known. But such information will take many years and much work to acquire, if indeed a static "best" method can ever be realized. Enough has been learned in the past several years to make possible the designing of a convenient and satisfactory standard technique for present use, if only those engaged in the taste-testing field are willing to work out the details and to compromise where necessary. Standard methods of analysis could be revised from time to time as better techniques are learned, and their adoption for routine problems will actually leave workers in the field with more time for the research that is necessary to uncover the physiological, statistical, and psychological facts that are basic to a complete understanding of organoleptic analysis.

35. PROGRESS REPORT ON THE WORK OF THE FOOD PROTECTION COMMITTEE

DAVID B. HAND, New York Agricultural Experiment Station, Geneva, New York

During its early deliberations the Committee developed terminology to differentiate chemicals intentionally added to foods for functional purposes and those which may be present incidental to production, processing, or distribution practices, and pointed out the distinction between the concepts of toxicity and hazard.

The Committee developed a statement of *Basic Principles Involved in Evaluating Safety in the Use of Chemical Additives in Foods*. This statement was released June 11, 1951. A statement of *Basic Considerations Involved in Evaluating Hazards Encountered in the Use of Pesticides on Foods* was prepared and likewise released on June 11, 1951. In November, 1952, the Committee adopted a statement of *Basic Considerations in the Development and Marketing of a New Agricultural Pesticide Intended for Use in Connection with Food Production*. This was developed as an advisory guide after consultation with industry and with Government agencies in regard to the need for an objective appraisal of the problem.

Meanwhile, in December 1951, the Committee published a comprehensive statement on the *Use of Chemical Additives in Foods*.

The Committee applied its guiding principles for evaluating safety of chemicals specifically to the use of emulsifying agents in food because this problem has been both prominent and highly controversial in the Food and Drug Administration's Hearings on Standards for Bread and again on Standards for Ice Cream and Related Products.

The Committee reviewed data available in 1950 on mono- and di-glycerides and polyoxethylene and similar type emulsifiers. A statement was issued in November 1951 to the effect that there was not then available to the Committee sufficient evidence to assure their safety for use in foods, especially emphasizing the need for further critical studies.

As a result the Committee received additional data which provides the foundation for the newest report which indicates *The Safety of Mono- and Di-glycerides for Use As Intentional Additives in Foods.*

Additional information on the polyoxyethylene type emulsifiers is now being assembled and studied to determine whether there are yet further data required to render judgment.

The Chemistry Subcommittee developed a compilation of *Analytical Methods for Pesticides*, the first section of which includes Aldrin and Dieldrin, Benzene Hexachloride, Chlordane and Heptachlor, and DDT.

36. PUBLIC EDUCATION REGARDING CHEMICALS IN FOODS

W. A. KREHL and GEORGE R. COWGILL, Department of Nutrition, Yale University

Consideration of this problem must recognize that several interests are involved: the public's health and safety; the food processor and how he uses chemicals in foods; and the Governmental agencies responsible for the administration of the food and drug laws as they exist. Due to poor publicity, certain extremist points of view, and ineptness in providing a proper climate for public opinion regarding chemicals in food, the several interests indicated above have tended to segregate themselves into factions, rather than develop an overall harmony of interests which will ultimately be needed to place the whole problem of chemicals in foods on a safe, yet sane, basis.

It must be the duty of all parties to remove the halo of mystery and suspicion concerning chemicals in food and present the facts in an objective way, colored as little as possible by the "legalisms" which tend only to cloud the issues. Nothing surpasses the plain unvarnished truth for conveying sound information.

As for the type of public education which makes for an intelligent public opinion, little if any aggressive action has been so far taken. An educational program should be considered as a function of an industry—wide research and information council which has as its primary responsibility the development of the educational material for presentation on an unbiased, objective basis for the home-economics teaching level, printed articles, radio, and television. The objective should be—*When there is a story to be told, tell it, but tell it correctly.*

37. MEDICAL QUESTIONS CONCERNING THE USE OF CHEMICAL ADDITIVES TO FOOD

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Medical men recognize that many foods are imperfect as they occur in nature. Furthermore, the destructive effects of oxidation, enzyme action in the living substances of the foods, and decomposition by microorganisms bring about further imperfections. Consequently, the application of human intelligence to the preservation and the improvement of foods is indispensable in modern life.

The ability to make vitamins synthetically (as well as many drugs) and to improve the digestibility of protein and carbohydrate food by laboratory-controlled procedures has been a great boon in the treatment of the sick and in public health measures to prevent illness.

Medical men expect that any such procedures for modifying food should meet the same criteria expected of a new food or a new drug. This refers to a demonstration of the utility plus the lack of significant harm under the conditions of use. Requirements will, therefore, include the facilities of physics, chemistry, pharmacological studies on experimental animals, and human usage tests under competent observation. Exact rules for all substances cannot possibly be made in advance. They must be developed by consideration of the individual case at the time of study.

38. MEETING THE DIETARY REQUIREMENTS OF MEN, INSECTS AND FUNGI IN THE UNITED STATES

GEORGE L. MCNEW, Boyce Thompson Institute for Plant Research, Inc., Yonkers, New York

In order to feed the expanding population, food production must be increased at a rate equivalent to bringing 100 million acres of new farmland into production during the next 25 years. This is impossible since only 15 million acres can be reclaimed and an equal amount can be released from feeding livestock such as draft animals. It follows that living standards will decline unless the yield per acre can be increased. Current losses of produce valued at about 2 billion dollars destroyed by plant disease, fungi and bacteria, 4 billion destroyed by insects, and 5 or 6 billion reduction due to weeds have to be further reduced to meet these demands.

Some diseases and insects are persistently destructive, causing losses of 5 to 15% each year, but most infestations fluctuate drastically from year to year depending upon climatic conditions. Examples of the first type are scab and codling moth on apples, brown rot and curculio on peaches. Examples of extremely irregular occurence are locust (grasshopper) and chinch bug infestations of the West and late blight of tomatoes in the East. Sometimes new races of cereal rusts appear and cause severe losses to heretofore resistant varieties of wheat, oats, etc.

Although much may be done to avoid extreme losses from insects, mites, fungi, bacteria and viruses by use of non-infested fields, proper planting dates, crop rotations, seeding of resistant or tolerant varieties and other cultural practices, chemicals must be depended upon as a major control measure. Many crops such as apple, peach, plum, corn, potatoes and tomatoes could not be grown in many of the major crop-producing areas without use of pesticidal chemicals. The production of many others would be hazardous and probably non-profitable.

Many of these biologically active chemicals, particularly the insecticides, are poisonous to warm-blooded animals. Fortunately most of them can be used so as to leave little if any residue and hence present only moderate hazards. Peach leaf curl, raspberry anthracnose, garden cutworms, scale insects, locusts, weeds and many other pests can be destroyed by dormant sprays, baits or treatments before fruit is set. Colorado potato beetle, potato blight and many other pests can be controlled by syraying non-edible parts of the plants. The control of pests on fruits and leafy vegetables offers the greatest hazard to the consumer. Many of these pests can be largely eliminated by intensive spraying early in the season and use of restricted schedules prior to harvest. In addition to proper scheduling of spray and dust treatments, residues may be reduced materially by proper formulation of pesticides so that proper particle sizes and dispersing agents are used.

39. LOSSES OCCURRING IN FOODS, AND WHAT IS BEING DONE ABOUT THEM

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Losses occurring in certain foods caused by molds and rots, staling, enzymatic and non-enzymatic browning are discussed. Molds and rots are being combatted by the use of improved harvesting, transportation, and storage methods and also by the use of improved fungicides. Fundamental research on the mechanism of browning and staling is leading to a better understanding of these reactions and may eventually show means of overcoming these and other deteriorative changes in food.

40. THE STATUS OF PROPOSED AMENDMENTS AFFECTING CHEMICAL ADDITIVES

BERNARD L. OSER, Food Research Laboratories, Inc., Long Island City, N. Y.

Pursuant to the hearings before the House Select Committee (82nd Congress) to Investigate the Use of Chemicals in Foods and Cosmetics, bills have been introduced into the 83rd Congress to amend the Federal Food, Drug and Cosmetic Act by

providing for the regulation of such chemicals. The extent to which these proposals meet the desired objectives, and how they compare with other proposals, are discussed. Consideration is given to the probable effects of the amended legislation on the operations of the food and chemical industries at both the policy making and technological levels.

41. THE METABOLIC APPROACH VERSUS THE TOXICOLOGICAL APPROACH TOWARD FOOD ADDITIVES

HARRY J. DEUEL, JR., Department of Biochemistry and Nutrition, University of Southern California School of Medicine, Los Angeles

A comparison is made in the metabolic and toxicological procedures for establishing the non-toxicity of proposed food additives. In the latter case, the general procedure has been to carry out prolonged feeding tests of the material under investigation at levels many times greater than the proposed level in foods. A minimum of 3 species of test animals is required, one of which must be a non-rodent. Pregnancy and lactation tests are advisable, especially over several generations with multigeneration studies. Histopathological examination of the organs is an essential part of this procedure.

The metabolic approach, where applicable, is recommended as simpler and more satisfactory for establishing the safety of proposed food additives. When the compound in question is metabolized through well-defined pathways to harmless end-products, one has excellent evidence of its innocuousness. An example of this approach is afforded by sorbic acid which behaves similarly to caproic acid.

42. THERMAL INACTIVATION OF PECTOLYTIC ENZYMES IN GENUINE DILL PICKLES

W. B. ESSELEN and E. E. ANDERSON, Department of Food Technology, University of Massachusetts, Amherst, Mass.

Thermal destruction data for pectin polygalacturonase in genuine dill pickles were obtained in the temperature range of 135° to 160° F. The thermal destruction curve has been characterized by an F_{150} value of 1.9 minutes and a z value of 17.7°. These data are in good agreement with the degree of pasteurization required to destroy this enzyme and prevent softening of pasteurized genuine dill pickles. Heat penetration data on quart and gallon jars of genuine dill pickles pasteurized at 180° F. are presented.

43. VARIETAL DIFFERENCES IN CUCUMBERS FOR PICKLING

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Evaluation of pickling cucumbers for suitability for commercial pickle manufacture was made of 30 varieties and strains grown in an important production area in the Texas-Arkansas region during a 4-year period. Sample lots of cucumbers representing early, mid-season and late harvests contained in cloth bags were brined in vats at a large pickle manufacturing plant. After the customary brine-curing period the salt-stock produced was evaluated with respect to firmness, bloater (hollow cucumber) content, length-to-diameter ratio and for acceptability for general commercial use. Marked varietal differences were shown in commercial acceptability for pickling purposes.

44. SOURCES AND TYPES OF MICROORGANISMS ASSOCIATED WITH THE SOFTENING OF FERMENTING CUCUMBERS

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A survey of the sources and types of microörganisms which might be associated with the softening of fermenting cucumbers (salt stock and fermented dill pickles) was conducted with a sodium polypectate gel as the screening medium. Possible sources examined included soils, fresh cucumbers, their blossoms and leaves, storage tank shavings, brines, water, salt, and pickling spices. The primary and greatest sources of softening organisms came from field contamination. Over 90% of all the pectinolytic cultures isolated were bacteria, predominantly of the genus *Bacillus*. The remainder were fungi. The pertinent physiology and taxonomy of these microörganisms will be discussed.

45. INFLUENCE OF VINEGAR EELS (ANGUILLULA ACETI) ON VINEGAR PRODUCTION

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A study of the nutritional requirements of *Acetobacter aceti* in the vinegar-making process has uncovered new information on the influence of vinegar eels. Pilot-plant size industrial vinegar generators and pure cultures of the organism were used throughout the work. Responses to the addition of nutrient salts to the diluted industrial alcohol medium were followed by acid titration and chemical measurement of alcohol content.

Where vinegar eels were introduced into the synthetic medium, the amount and rate of acid (measured as acetic) produced was higher than in those generators from which vinegar eels were strictly excluded. In addition, the efficiencies of conversion of alcohol to acetic acid in the process was significantly higher in the vinegar generators containing vinegar eels than in those free of vinegar eels. In what way the vinegar eels can favorably influence the bacterial metabolism of *Acetobacter aceti* has not yet been clear. It is conjectured, however, that the vinegar eels depend on the bacterial cells in the generators as a source of food, and that they, in turn help the *Acetobacter* by decomposition or separation of soluble nutrients essential for the acetification process.

46. FERMENTATION OF SAUERKRAUT AS AFFECTED BY SALT AND TEMPERATURE

CARL S. PEDERSON and MARGARET N. ALBURY, New York State Agricultural Experiment Station, Cornell University, Geneva, New York

In previous studies, the fermentation of cabbage to sauerkraut has been ascribed to 3 species of lactic acid producing bacteria. Due to the interest in color, texture and other quality factors of sauerkraut, it seemed advisable to determine the effect of temperature of fermentation and of salt concentration upon the course of the fermentation and the quality of the end product.

It has been found that when 3½% salt is used instead of the usual 2¼%, a fourth species of lactic acid producing bacteria, *Pediococcus cerevisiae* may play a significant part in the fermentation. Likewise when the kraut is fermented at temperatures of 32° or 37° C., instead of the lower temperatures, this species is important in the fermentation. The species *Leuconostoc mesenteroides* is nearly always important in starting fermentation, but it has been found to persist longer in low salt content krauts.

The quality of kraut fermented at 32° and 37° C. with normal salt content was inferior to that fermented at 19° and 22° C. This difference was particularly noticeable in color. Likewise, the color of kraut fermented at 22° C. with 3½% salt was poor and in at least one season's pack developed a pinkish cast indicating abnormal yeast growth. Kraut packed with only 1% salt had a very light color but it was very soft in texture.

47. FACTORS AFFECTING THE QUALITY OF CUCUMBER PICKLES

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Cucumber stock cured in brine at 19-23° C. (66-73° F.) during the 1952 season showed slow acid production. Addition of pure cultures of lactobacilli or leuconostoc had no advantage over the conventional method of curing since the amount of acid produced was similar to that produced by curing without pure culture inoculation. From the past year's studies considerable doubt has arisen concerning the importance of microörganisms in the curing of cucumbers for sweet pickles. The addition and maintenance of definite concentrations of lactic acid to initial curing brines and subsequent building up of salt concentration

gave a final cured product, the quality of which appeared to be as good as that cured by the fermentation curing process.

Aëration of the brine covering the cucumber stock or daily addition of 1.0% salt to the initial 6% brine up to 20% resulted in a lower total acid production than in the normal cured stock. The addition of 1.0% sucrose to cucumber stock daily for 15 days resulted in a higher acid production, but gas was also abundant and there was evidence of severe plasmolysis.

Storage studies on commercial packed sweet mixed pickles provided some interesting results. Temperature and light play an important part in the quality of the finished product. Some brands of pickles actually improved in quality at storage temperatures above 40° F. Other brands deteriorated in quality with increased storage temperature. Storage of pickles in clear glass in light usually resulted in a marked deterioration of quality.

Studies on the production of green colour in cured, freshened stock were continued in 1952 with a completely new approach to the problem. Results suggested that various compounds, plus heating, initiate a desirable green colour development.

48. THE INFLUENCE OF GRAM-NEGATIVE BACTERIA ON THE SAUERKRAUT FERMENTATION

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Aerobacter cloacae and *Flavobacterium rhenanus* were identified as members of the gram-negative group that were found to increase in numbers during the beginning stages of the normal sauerkraut fermentation. *A. cloacae* was the more prevalent of the two since it was isolated in 5 out of the 6 fermentations. The measurement of the oxidation-reduction potentials during the normal fermentation showed that the pH decreases with the growth of the gram-negative bacteria. When a large inoculum of *A. cloacae* was placed in sterile cabbage juice with an inoculum of *Leuconostoc mesenteroides* or other acid-forming bacteria, the formation of acid was retarded. With a smaller inoculum *A. cloacae* apparently produces favorable conditions for the growth of *L. mesenteroides* as indicated by a greater acid formation in the mixed culture.

Introduction of large numbers of *A. cloacae* into the natural sauerkraut fermentation showed that this organism was capable of causing dark sauerkraut and at the end of 2 weeks produced a sharp radish-like flavor which was undesirable. The exposure of such sauerkraut to the air intensified darkening.

49. EFFECT OF PEROXIDASE CONCENTRATION, ACIDITY, AND STORAGE TEMPERATURE ON THE DEVELOPMENT OF OFF-FLAVORS IN FRESH PACK PICKLES

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Additional data on the relationship of peroxidase activity to off-flavor development in fresh pack pickles are reported. High degrees of peroxidase activity have been associated with the development of bitter flavors in this product. The development of off-flavors in pickles containing active peroxidase is markedly increased during storage at 40° F. as compared with storage at 70° F. or 100° F. Enzyme inactivation during storage at the higher temperatures may be responsible for this situation.

The addition of purified preparations of cucumber and horseradish peroxidase caused the development of off-flavors in fresh-pack pickles similar to those observed in underprocessed pickles. The addition of a catalase preparation decreased the intensity of the off-flavor associated with peroxidase activity, but in itself resulted in the development of slight but definite and characteristic off-odor.

Data on the effect of acetic acid concentration on the thermal inactivation of peroxidase in cucumbers are presented.

50. THE FERMENTATION OF GREEN TOMATOES

CARL S. PEDERSON and MARGARET N. ALBURY, New York State Agricultural Experiment Station, Cornell University, Geneva, New York

Green tomatoes are used in preparing relishes and sometimes in mixed pickles or as dill pickles. Early frosts often stop development of large numbers of green tomatoes that could be used if they could be handled rapidly.

The fermentation and curing proceeds slowly even in low salt brines. Puncturing the skin of the tomato seemed to release nutrients so that fermentation could proceed more rapidly. In low salt content brines, fermentation was due to the species *Leuconostoc mesenteroides, Lactobacillus plantarum* and *Lactobacillus brevis*. In lots in which progressively higher concentrations of salt were used, the relative influence of the leuconostoc was lessened. Fermented green tomatoes can be used in a manner similar to that employed for fermented cucumbers. Some of the more mature green tomatoes may color somewhat during fermentation.

51. OBSERVATIONS ON DRIED BEVERAGE BASES FROM FRUITS

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Experiments reported in 1929 and 1949 were resumed during the past 2 years. It was found that if sufficient sucrose or dextrose is added to blends of several suitable fruit juices or concentrates they give, on vacuum drying, readily soluble, bone-dry products that are relatively non-hygroscopic and very satisfactory for preparing fruit punch and other refreshing beverages. Without added sugar the dried juices were very hydroscopic and of less pleasing flavor than when sufficient sugar was used. At room temperature rate of loss of Vitamin C was slow.

52. HEAT-INDUCED INHIBITORY AGENTS OBTAINED FROM PROCESSED FRUITS AND VEGETABLES

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Inherent antibiotic substances in fruits and vegetables were destroyed under tests when processed at times and temperatures commonly employed in commercial canning. Fruits and vegetables subjected to heat treatments ranging from the recommended commercial processes to those employing temperatures of 212° F. for 24 hours and 250° F. for 8 hours produced substances which were in many instances inhibitory to microorganisms. Fruits and vegetables producing the greatest amount of inhibitory substances were apples, peaches, plums, onions, garlic and peppers. Reduction in growth of microörganisms effected by the heat-treated sucrose solutions paralleled the amount of furfural and hydroxymethylfurfural in these solutions.

The higher concentrations of sucrose solutions (30 to 40%) when heated to 250° F. for 4 and 8 hours produced inhibition in the growth of *Escherichia coli, Bacillus subtilis, Micrococcus pyogenes* var. *aureus, Lactobacillus plantarum, Leuconostoc mesenteroides, Acetobacter aceti, Bacillus thermoacidurans*, and *Saccharomyces ellipsoideus*. The growth of *Lactobacillus lycopersici* was enhanced by the heat treatment of the sucrose solution.

53. STORAGE CHANGES IN PROCESSED APPLE SAUCE

G. E. LIVINGSTON, W. B. ESSELEN and C. R. FELLERS, Department of Food Technology, University of Massachusetts, Amherst, Massachusetts

A number of chemical and physical changes occuring in apple sauce packed in glass containers and held at various storage temperatures were followed over a year's time. Physical measurements carried out at monthly intervals included reflectance readings and viscosity determinations on portions of the sauce, and transmittance readings on the deflocculated juice. Chemical tests included determination of pH, total acidity, methoxy content of the pectin fraction (5-hydroxymethyl)-2-furaldehyde (HMF), glucose, fructose and sucrose, and ascorbic acid in samples to which the latter had been added.

Results indicated that a breakdown of the sugar and pectin fractions which occurs in storage is primarily a function of storage temperature. With this breakdown there is a resulting increase in acidity and HMF content, and a decrease in viscosity.

A surface darkening which occurs in stored apple sauce was due to an oxidative reaction: involving with some types of container closures, the seepage of external oxygen into the container. The darkening was prevented either by the use of impervious closures or by the addition of ascorbic acid to react with the free oxygen. The nature of the reactants involved is not known, al-

though sugars were found to contribute to the rate of this type of darkening.

The diffused non-enzymatic darkening of apple sauce which occurs at elevated temperatures or over prolonged storage periods is thought to be due to a number of nonoxidative reactions. Among these, sugar and pigment degradations and a malic acid-fructose reaction are considered to be possible darkening mechanisms.

Six varieties of Massachusetts' apples were studied for their susceptibility to oxidative storage darkening.

54. PASTEURIZATION AND STORAGE OF SWEETENED AND UNSWEETENED LIME JUICE

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Sweetened and unsweetened lime juices were heated for 5 seconds at temperatures ranging from 120° to 200° F. (in 10° F. steps) and stored at 35°, and 80° F. in 4-oz. cans. The sweetened juice was prepared from a portion of the unsweetened 8.8° Brix juice by adding sucrose to 45° Brix.

A temperature of 150° F. was effective in reducing the number of microörganisms to a low level, but a temperature of 170° F. was required to prevent clarification. At 35° F. storage, heated samples remained practically unchanged in flavor for 15 months but some changes were observed in the unheated. Differences between sweetened and unsweetened samples were minor as far as flavor, enzyme inactivation, and destruction of microörganisms were concerned. At 80° F. storage off flavors developed in all samples within 5 months. Pasteurization at 170° to 200° F. followed by storage at 35° F. provided a satisfactory method of handling both sweetened and unsweetened juices.

55. LEACH PRESSING OF APPLES: A METHOD OF INCREASING THE YIELD OF FULL-FLAVOR JUICE CONCENTRATE

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An improvement in the manufacture of apple juice concentrate is presented. This method, "leach pressing" of the apples, gives 12 to 18% greater yield of concentrate per ton of apples than the conventional method of pressing. The apples are first pressed as usual. Then the cakes of pomace are torn apart by a "picker" or a slow-speed hammer mill, water of approximately equal weight is added, and the mass again pressed. When this is done promptly, no undesirable flavor is imparted to the concentrate made from the mixed juice. The water added is, of course, removed in evaporating the juice to make concentrate; therefore, no dilution of the final product is caused. Experimental runs were made using 3 different amounts of added water. For each of the 3, yields were obtained and full-flavor concentrate made, with essence returned to it. The concentrates were compared organoleptically, after diluting to juice strength, with concentrate made from the same apples using conventional single pressing. Although the costs of evaporation are obviously increased, this is more than offset by the increase in yield, with the result that the net financial return is appreciably greater. Complete commercial cost estimates of making concentrate at each of the 3 dilutions were made; these showed that a moderate dilution gave the best economic return.

56. GRAPE JUICE POWDER

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A pilot-plant process is described for making powdered grape juice. The starting material is grape juice manufactured in the conventional manner. The volatiles are first stripped from the juice and recovered as an essence using the method developed by the Bureau of Agricultural and Industrial Chemistry. The stripped juice is then depectinized and concentrated under vacuum to about 84° Brix. The previously recovered volatiles are then restored and sucrose solution of the same Brix as the concentrate is added so that approximately 33% of the total solids in the mixture is sucrose. The mixture is then dried in a vacuum tray drier to about 2% moisture. The total drying cycle is about 2½ hours. The conditions of drying are so controlled as to avoid the development of off-flavors and to permit the restored essence to react with the concentrate and produce a flavorful product.

The dried concentrate is cooled in the drier while still under vacuum. It is then ground and packaged in a low-humidity atmosphere. The product remains in the can in the form of a free-flowing granular powder through the action of an inpackaged desiccant. The powder dissolves in cold water to give a juice of good grape flavor. Storage tests are in progress.

57. STABILIZATION OF FROZEN CITRUS CONCENTRATES BY HEAT TREATMENT

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A series of experiments on stabilizing the cloud in orange juice concentrates was performed to obtain information concerning the effects of different temperature levels of heat treatment, the effects of concentration on a given heat treatment, and the effects of holding time on different temperature and concentration levels. Three temperatures, 150° F., 175° F., and 200° F.; 2 holding periods, 1 second and 20 seconds; and 4 concentrations, 12°, 27°, 43°, and 58° Brix., were employed in a factorial design in which all combinations of temperatures, holding times, and concentrations were investigated. All heating was done with an experimental scale direct steam injection unit. The effects of these treatments were determined by measuring flavor damage, cloud loss, and residual pectinesterase activity of the treated concentrates.

The results indicate that direct steam injection can be used to effect a wide range of heat treatments which result in increased cloud stability without causing detectable flavor damage as determined by triangular taste tests. There appears to be a significant effect upon the resulting cloud stability depending upon the combination of concentration and temperature of the heat treatment. The degree of cloud stabilization showed a general but not quantitative agreement with the amount of pectinesterase inactivated.

58. GELATION AND CLARIFICATION IN CONCENTRATED CITRUS JUICES. IV. CHANGES IN PECTIC SUBSTANCES DURING STORAGE

JAMES H. DIETZ, Florida Citrus Experiment Station, Lake Alfred, Florida

Changes in pectic substances occurring in orange and grapefruit concentrates during storage at 80° F. were investigated over a 48-hour storage period. The pectic substances were divided into 3 fractions by extraction procedures and then were determined colorimetrically as anhydrogalacturonic acid by the carbazole method. The changes in water-soluble, polyphosphate-soluble, and alkali-soluble pectic fractions were compared with the occurence of gelation and clarification. An attempt was made to explain the underlying reactions leading to gelation and clarification in concentrated citrus juices.

59. DISTRIBUTION OF PECTINESTERASE AND TOTAL PECTIN IN COMPONENT PARTS OF CITRUS FRUITS

A. H. ROUSE, Florida Citrus Experiment Station, Lake Alfred, Florida

Pectinesterase activity and total pectin are reported on wet tissue and dry solid basis for 6 component parts of seven varieties of mature citrus fruits. The component parts consisted of the flavedo, albedo, rag, juice sacs, and juice found in one variety of mandarins, 4 varieties of oranges, and 2 varieties of grapefruit. The juice sacs and rag, which are the chief components of the pulp content of a citrus fruit or concentrate, were found to be extremely active in pectinesterase and relatively high in pectin content.

60. SUGAR HYDRATE FORMATIONS IN FROZEN CITRUS CONCENTRATES

R. W. OLSEN and E. L. MOORE, Florida Citrus Experiment Station, Lake Alfred, Florida

The undesirable change in appearance and texture caused by the formation of sugar hydrates in frozen grapefruit concentrates

and limeades has presented a major problem to the citrus industry. To obtain much-needed background information on this new problem, 46 exploratory packs of these products were prepared and stored during the 1951-52 season to determine the effect of different sugars, heat treatment, and packaging on these formations. Results are discussed in the present paper.

61. FROZEN CONCENTRATED CITRUS JUICES—CO-PACKER QUALITY CONTROL

HERBERT S. MADSEN, Production Manager; A. D. D'ERCOLE, Quality Control Supervisor, Citrus Division, Birds Eye Division, General Foods Corporation, Lakeland, Florida

Application of quality control procedures under co-packer relationships requires both diplomatic and technical competence. Buyer (eventual marketer) and seller (packer) have primary objectives which may be divergent. In this kind of arms-length partnership, side by side interpretation of laboratory quality control data and subjective tests is the most workable system of assuring satisfaction to both parties.

The development of objective methods of assaying quality factors has helped greatly to define quality standards (specifications). Subjective methods, as facsimiles of eventual consumer reactions, must, however, in the long run guide most final quality decisions.

61A. DETERMINATION OF FREE GALACTURONIC ACID IN CITRUS PRODUCTS

V. V. ALMENDINGER, C. A. DILLMAN and C. G. BEISEL, Research Department, Real Gold Citrus Products, Anaheim, California

The presence of abnormal amounts of free galacturonic acid in fruits probably is a measure of decomposition. If the concentration of galacturonic acid could be used as an index of this condition, processors for citrus fruits would have an objective basis for elimination of undesirable lots.

A study of methods employing the Tollens reaction of uronic acids with napthoresorcinol resulted in a modification of the techniques employed by Winkler and Mills, i.e., separation of organic acids by ion exchange and colorimeter determination of galacturonic acid.

The application of the method to citrus products is presented. Determinations were made on processed Valencia and Navel juices and concentrates. Data on lemon products are also given.

Free galacturonic acid appears in citrus products in very small concentrations; there is no relation between galacturonic acid content and any other factor important to the processor or shipper.

61B. STUDIES ON THE PROCESSING OF RED CHERRIES. III. A COMPARISON OF FRUIT FROM DIFFERENT GEOGRAPHICAL REGIONS

CLAUDE H. HILLS and R. T. WHITTENBERGER, Eastern Regional Research Laboratory, Philadelphia 18, Pennsylvania

In 1952 a total of 26 processing plants were visited in Pennsylvania, New York, Wisconsin, and Michigan, and samples of cherries were canned in 17 of the plants. There was considerable variation in the quality of canned fruit, the variation being greater within regions than between regions. Most of the differences in texture and drained weight seemed to be associated with differences in handling the fruit prior to and during processing.

High drained weight ratios commonly were associated with firm texture of the canned fruit, low percentage of torn cherries, relatively poor color, appreciable scald, low pitting loss, and a long soaking period. When cherries were processed promptly after harvest, the product usually had the opposite characteristics. In none of the geographical regions were the preprocessing treatments of the fruit completely standardized.

62. DEHYDRATED STABILIZED EGG. IMPORTANCE AND DETERMINATION OF pH

HAROLD SALWIN, I. BLOCH, and J. H. MITCHELL, JR., Quartermaster Food and Container Institute, Chicago, Illinois

Flavor and functional properties of dehydrated egg are dependent upon the pH of the reconstituted powder. With an acid condition there are flavor and texture defects and loss of aerating power. An over-alkaline condition leads to flavor, texture, and color defects. These factors have been evaluated in the case of dehydrated stabilized egg which presents a special problem in pH control.

Stabilized egg is manufactured by a process designed to improve the flavor stability. After the liquid egg is pasteurized, it is acidified with hydrochloric acid and then dried. Sodium bicarbonate is added to the egg powder in order to restore the normal pH at the time of use. During reconstitution of dehydrated stabilized egg, carbon dioxide is generated by the reaction between hydrochloric acid and sodium bicarbonate. In order to obtain a reliable measure of pH the carbon dioxide must be removed under uniform conditions. This was accomplished by cooking the samples in steam for 10 minutes. In addition to standardizing the test, the method of cooking the reconstituted egg before measuring the pH is more sensitive to variations in acidity and alkalinity. Consequently, the method gives more informative results regarding deviations in pH which are responsible for quality defects.

The results of laboratory consumer preference tests and the effects of variations in pH on the flavor, color, and texture of scrambled eggs are discussed. The relationships of pH to aerating power and to the quality of sponge cakes are also presented.

63. INFLUENCE OF LIPIDS ON SELF-DISPERSION AND ON EASE OF DISPERSIBILITY OF WHOLE MILK POWDER

W. K. STONE, T. F. CONLEY, and J. M. MCINTIRE, Quartermaster Food and Container Institute, Chicago, Illinois

The redispersing characteristic of whole milk powder are different from those of nonfat milk powder. Milk fat was thought to be the principal material responsible and hence its physical state as affected by temperature was of great interest. It was found that self-dispersion and ease of dispersion with agitation increased at temperatures near the melting zone of the milk fat. Liquid edible vegetable oils sprayed into milk powder also increased self-dispersion and ease of dispersibility. However, the beneficial effects decreased in storage.

Another approach tried was to extract "free fat" from whole milk powder. In general, this lowered self-dispersion and increased the ease of dispersibility.

The data obtained are significant in that the fat constituents of dry whole milk are shown to be an influence on its dispersing characteristics.

64. CALCIUM REMOVAL FROM FLUID MILK BY ION EXCHANGE

RICHARD D. COLEMAN, SOLOMON J. BISHOV, and J. H. MITCHELL, JR., Quartermaster Food and Container Institute, Chicago, Illinois

High temperature heat treatment of milk to increase resistance to lipid oxidation is a commercial practice in the manufacture of dry whole milk and other dairy products. Denaturation of serum proteins and lowered dispersibility of casein are often undesirable resultants of this treatment. Evidence exists that partial removal of calcium from milk increases the resistance of proteins to heat induced changes. This paper describes the use of synthetic resinous ion exchangers in the removal of calcium from milk. A larger portion of calcium may be removed from milk with less change in sensory rating by the use of anionic and cationic resins in intimate mixture than by the use of these resins singly or in series.

65. ESTERS OF CITRIC ACID IN STABILIZING EDIBLE OILS

HANS W. VAHLTEICH, CHESTER M. GOODING, CARL F. BROWN and DANIEL MELNICK, Research Laboratories, The Best Foods, Inc., Bayonne, N. J.

There is a need for certain organic acids in vegetable oils for counteracting the pro-oxidant effect of the trace metals present, principally iron and copper. Whereas citric acid is used to some degree as a metal deactivator, the mono-esters of citric acid are preferred. The free acid is an effective material, but in using this compound, the operator has no control over what remains qualitatively and quantitatively in the finished oil. The possibility of

corrosion of equipment, when free citric acid is added during the deodorization process, cannot be disregarded. Far higher concentrations of metal deactivator are readily attained with the esters of citric acid. The esters of citric acid, to be effective, must have at least 2 free carboxyl groups. The stabilizing influence of isopropyl citrate and stearyl citrate ester preparations in stabilizing vegetable oils, before and after hydrogenation, is supported by objective flavor scorings. A modified A.O.M. test, utilizing under standardized conditions iron tubes in place of the customary glass tubes and an expert flavor panel for flavor scorings, has demonstrated the desirability of higher concentrations of metal deactivators in fats. The superiority of the citric acid esters over other commercially available antioxidant mixtures in vegetable oils has been noted in the modified A.O.M. test. The isopropyl citrate and stearyl citrate ester preparations have both been approved by Federal agencies for use in stabilizing oils and fats.

66. UNSATURATED FAT OXIDATION CATALYZED BY HEMIN, HEMOGLOBIN, AND CYTOCHROME C.

A. L. TAPPEL and M. R. EMERSON, Department of Food Technology, University of California, Davis, California

There is evidence indicating that the hematin compounds are the predominant unsaturated fat oxidation catalysts in animal tissues. The hematin compounds appear to be the catalysts responsible for the oxidative rancidity occurring during the frozen preservation of pork and fish.

Studies of linoleate oxidation at 0° C. show that hematin compounds are among the most powerful linoleate oxidation catalysts known. During the linoleate oxidation the hematin catalysts are destroyed. The co-oxidation may account for the bleaching of hemoglobin which is known to occur during the storage of pork. Antioxidants are effective inhibitors of hematin catalysts because they effectively interrupt the chain reaction oxidation of linoleate. Linoleate oxidation catalyzed by cytochrome C. and hemoglobin has the remarkably low activation energy of 3.3 kilocalories per mole. In practical terms this low activation energy indicates that food products undergoing unsaturation fat oxidation catalyzed by hematin would be protected relatively little by temperature reduction.

67. SIGNIFICANCE OF THE BROWNING REACTION IN THE DETERIORATION OF STORED GRAIN

C. E. MCDONALD and MAX MILNER, Kansas State College, Manhattan, Kansas

Deterioration in stored wheat known commercially as germ-damaged or "sick wheat," which is manifested by discoloration of the embryo, has been shown in the present studies to be due to a non-enzymatic browning reaction of the Maillard type. Colorimetric and fluorometric changes in the extracts of the discolored germ of damaged wheat and of unprocessed wheat germ browned by storage at elevated temperature and moisture values are shown to parallel closely the development of brown colors. The characteristics of the gas exchange of wheat embryos undergoing browning are quite different from those exhibited by fungi which may poliferate on this tissue under certain conditions.

68. EVALUATION OF CONCURRENT FEEDING OF COMPLEMENTARY FOOD PROTEINS TO MAN

ALEXANDROS S. MALASPINA and ROBERT S. HARRIS, Department of Food Technology, Massachusetts Institute of Technology, Cambridge, Mass.

The effects of the concurrent and non-concurrent feeding of foods containing complementary proteins were compared and evaluated in adult male subjects. In the first of two series of experiments a subject took 250 g. of beans and 250 g. of corn daily as the sole source of protein. An intake of 2900 calories was assured by supplementation of the corn and bean diet with hydrogenated fat and sugar. During the first and third period of nine days he took corn and beans in each of 4 meals—8 a. m., 12 M., 4 p. m., and 8 p. m. During the second period of 9 days the corn and beans were taken in alternate meals. In the second similar experiment 4 subjects took 200 g. of beans and 200 g. of corn daily. The caloric needs were supplied by additions of hydrogenated fat, sugar, jellies, and ginger ale. Two subjects took the corn and beans concurrently during the first and third 7 day period, while the other 2 subjects consumed them non-concurrently. The first 2 subjects took these foods non-concurrently during the second 7 day period while the other 2 subjects took them concurrently.

A lower excretion of nitrogen was observed during the period of concurrent feeding in 3 of the 4 subjects and in 4 of the 5 trials, indicating that the complementary proteins of corn and beans are better utilized when these foods are ingested together.

69. COMPARATIVE NUTRITIVE VALUES OF MONO-, DI- AND TRIGLYCERIDES FED AT EQUICALORIC LEVELS IN THE DIETS OF RATS

ROBERT S. HARRIS and HENRY SHERMAN, Department of Food Technology, Massachusetts Institute of Technology, Cambridge, Mass.

Male weanling rats were fed mono-, di-, and triglycerides, and a mixture of these, in synthetic and in natural diets for 70 days in equicaloric amounts on a restricted paired-feeding basis. No significant differences in body weight increase or caloric efficiency were noted. It is concluded that the nutritional values of these fats are the same, calorie for calorie.

70. PHYTATES, NUTRITION AND FOOD PROCESSING

ROBERT S. HARRIS and FELIX BRONNER, Department of Food Technology, Massachusetts Institute of Technology, Cambridge, Mass.

For more than 30 years investigators have been concerned with the effect of naturally occurring food phytates on the absorption of mineral elements. The experimental evidence bearing on this subject has often been contradictory and as a result the food processor has in many cases been unable to evaluate the importance of phytates. Recent evidence has clarified this problem and has indicated the conditions under which positive action is warranted.

71. CRUMB SOFTNESS FROM SOY FRACTIONS

C. W. OFELT, ALLAN K. SMITH, and PAUL A. BELTER, Northern Regional Research Laboratory, Peoria, Illinois

The effects of 2 soy products (1) Gelsoy, and (2) whey solids on crumb firmness have been studied in the laboratory. Gelsoy has been used in a single commercial baking trial. Gelsoy (1%) doughs had handling qualities equal to doughs containing 0.5% POEMS, and the bread crumb was resilient in contrast to the crumb of bread containing POEMS. Both Gelsoy and whey solids caused a marked decrease in crumb firmness although not as great as that obtained with 0.5% POEMS. Use of 1% Gelsoy allows an increase in absorption of 1% and requires a small increase in oxidizing agent.

72. EVALUATION OF THE FLAVOR OF ANGEL CAKES PREPARED FROM YEAST FERMENTED AND ENZYME TREATED DRIED ALBUMEN

AGNES FRANCES CARLIN, JOHN C. AYRES, and PAUL G. HOMEYER, Departments of Home Economics Research, Bacteriology, and Statistics, Iowa Agricultural Experiment Station, Ames, Iowa

Investigation of factors that affect purity, color, solubility and stability have resulted in many improvements in the quality of dried albumen. However, in the final analysis, consumer acceptance of products prepared with dried albumen depends, to a large extent, upon the flavor. Flavor is not easily measured; hence there is a dearth of information that would permit an answer to such questions as "Can the consumer distinguish between the flavor of angel cakes made with fresh or dried egg white?" or "To what extent does the agent used in removal of the glucose or the method used for drying affect the flavor of angel cakes made with dried albumen?"

This investigation was planned to study some of the factors which would influence flavor evaluation of angel cakes prepared from different samples of dried albumen. Comparisons were made between cakes prepared from dried egg samples that had been yeast fermented or enzyme treated prior to drying, and between cakes that contained spray dried or tray dried albumen

samples. Results obtained from small laboratory panels and large consumer groups are discussed. The triangle of odd sample test was the method used to record differences by both groups: the laboratory panel ranked the cakes also. Information was obtained on the age and smoking habits of the members of the panels. The influence these factors had on the individual's ability to identify the odd sample will be reported.

73. COMPARISON OF OBJECTIVE TESTS FOR QUALITY OF GULF SHRIMP

E. A. FIEGER and J. J. FRILOUX, Department of Agricultural Chemistry and Biochemistry, Louisiana State University, Baton Rouge, Louisiana

Fresh caught Gulf shrimp stored in crushed ice were sampled daily for chemical, bacteriological and organoleptic tests. Separate lots of shrimp were used in 3 experiments. Of the 4 chemical tests used to determine quality the tyrosine reaction was shown to be of little or no value. Determinations of trimethylamine nitrogen and volatile acids were of value in indicating whether spoilage had occurred, but did not give information of pre-spoilage changes. Significant increases in bacterial plate counts preceeded by 2 or 3 days similar increases in volatile acids and trimethylamine nitrogen values. Amino nitrogen values decreased with increasing storage time and correlate quite well with taste panel tests of flavor and quality.

The results of taste panel testing are of particular value to the shrimp industry. During the first 7 days of ice storage the shrimp gradually lost their characteristic sweet flavor. This was followed by a period of 7 days during which they were tasteless. Beyond 14 days storage spoilage occurred with the development of off flavors. It is postulated that loss of quality during the early period of storage is mainly caused by autolysis; with longer storage spoilage occurs mainly through bacterial action.

74. CHEMICAL COMPOSITION OF CERTAIN SPECIES OF FRESH-WATER FISH

I. INTRODUCTION: THE DETERMINATION OF THE RANGE AND AVERAGE COMPOSITION OF FISH

M. E. STANSBY, Chief, Pacific Coast and Alaska Technological Research, U. S. Fish and Wildlife Service, Seattle, Wash.

A comprehensive survey of the proximate composition of commercially important fresh-water species of fish is being undertaken. Because of wide variation in composition of individual fish of the same species, special precautions in obtaining adequate, representative samples must be taken in order to allow for seasonal and geographical variations. Analyses for the content of oil, total nitrogen, moisture, and ash in the edible flesh and in the trimmings of Great Lakes and other fresh-water fish are being carried out, and an estimation of the cold-storage life of these fish in the frozen state is being included.

75. OBSERVATIONS ON THE CANNING OF PACIFIC COAST OR DUNGENESS CRABMEAT

LIONEL FARBER, George Williams Hooper Foundation, University of California, San Francisco

Canning West Coast crabmeat involves 4 factors which have to be eliminated or largely minimized to enable an acceptable canned product to be prepared. These are the shrinking, blueing, scorching or browning and toughening of the meat which are often found in the canned product. Shrinkage of the meat, occurring mainly during the sterilization period of the cans, can be overcome by adequately precooking the raw crabs. The progressive blueing of the meat in the can during storage may be largely minimized or even prevented by removing as much blood as possible from the crabs by bleeding the live crabs and thoroughly washing them before and after they are precooked. The use of a weak brine containing sodium citrate assists in the blood removal. Scorching of the crabmeat is mainly the result of an improper retorting procedure with inadequate cooling of the cans after the completion of the retort process. By promptly cooling the cans in water after the heating period no brown discoloration will develop.

The usually employed acid treatment of the picked crabmeat to inhibit the subsequent blueing of the meat in the can results in a marked alteration of the texture of the meat with its becoming stringy and tough. By using sodium citrate instead of citric acid, for example, the beneficial effect of the citrate ion is still obtained with no marked alteration in the texture of the meat. Furthermore, the addition of a small amount of a salt solution of sodium citrate to the can prevents any further changes during the retorting period. The canned meat prepared in this manner has a texture very close to that of the precooked crabmeat. The foregoing suggestions have been used by a commercial packer and a most acceptable canned product has been obtained.

76. THE DETERMINATION OF VOLATILE REDUCING SUBSTANCES AS AN AID IN QUALITY CONTROL OF CANNED FISH SUCH AS TUNA

LIONEL FARBER and ANNE CEDERQUIST, George Williams Hooper Foundation, University of California, San Francisco

A survey was made of the content of Volatile Reducing Substances (V.R.S.) in canned tuna packed throughout the state of California. The ranges and averages of the V.R.S. values for different styles of Albacore, Bluefin, Skipjack, and Yellowfin in oil are presented. The possible use of such determinations in checking the efficacy of operating procedures and the quality of the packs is discussed.

77. THE MAILLARD REACTION IN FLESH FOODS WITH SPECIAL REFERENCE TO FISH

H. L. A. TARR, Fisheries Experimental Station, Vancouver, B. C.

It was shown previously that typical Maillard browning occurs in heated flesh of certain fish, and the present investigation has established that, at least for the varieties of fish examined, the limiting factor in determining this browning is free D-ribose. This ribose apparently arises through enzymic degradation of the nucleic acid of fish nucleotropomyosin, and it is formed from added ribose nucleic acid, nucleotides or nucleosides. Evidence will be presented relating to the relative roles of the free ribose and glucose of fish and meats in occasioning the Maillard browning occurring during heating, dehydrating, etc. Theoretical and practical techniques of overcoming the browning will be discussed.

78. ARMED FORCES RESEARCH AND DEVELOPMENT PROGRAM FOR SEAFOODS

S. R. PETERSON, Quartermaster Food and Container Institute, Chicago, Illinois

The Armed Forces have a distinct interest in research and development work on any and all high-protein foods. Seafoods, in addition to being high in protein, have other excellent nutritional qualities, are in abundant supply, will help to diversify the serviceman's menu, and—of utmost importance in view of the vast subsistence requirements of the Armed Forces—will expand procurement resources by adding the sizeable and well-organized fish industry to the lists. As the Armed Forces' organization assigned primary responsibility for food research and development for the three Departments, the Quartermaster Food and Container Institute is therefore initiating a program which will be gradually increased in coming years to encompass as many phases of seafood research and development as can be expected to result in stable seafood products for Armed Forces use. Present objectives are: (a) fresh and frozen products for the garrison type of feeding at home and overseas, (b) acceptable dehydrated food items, and (c) acceptable canned fish combination items. Critical factors related to processing, storage, behavior, and preparation are the objects of present concern, but there has not been time as yet to formulate a complete investigative program. At the moment the Qm. Institute is seeking to keep abreast of research work being done by organizations such as are represented at this meeting. It is believed that at least a dozen canned fish combination items can ultimately be made available for operational rations. To meet Armed Forces requirements, these canned seafood products will have to have a storage life of at least one year at 100° F., and must be palatable when eaten cold during field operations. In terms of long-range effort, acceptable canned seafood items are desired that are capable of withstanding temperatures in the range of −85° F. to 160° F. for 2 years. Products are also required for large group feeding overseas, i.e., for the B-ration. For this purpose the products must be packed in large cans and must retain the flavor, color, and texture to the same extent as those packed in small cans.

79. OPTICAL DENSITY AS A MEASURE OF THE QUALITY OF FROZEN CHINOOK SALMON

H. O. A. OSMAN and O. J. WORTHINGTON, Oregon State College, Corvallis, Oregon

Paired half steaks of Chinook salmon were packed in polyethylene bags in waxed cartons, quick frozen and stored at 0°F. for a maximum period of 10 months. One of the pair was given an ascorbic acid dip before packing. At intervals of 8 weeks the steaks were examined for peroxide values and optical densities of the oil at 3 wave lengths. Correlation coefficients with replicated scores of a selected panel were calculated.

In these preliminary experiments the optical density at 450 mμ, 460 mμ or 470 mμ is shown to correlate significantly with panel scores and thus shows promise as a rapid objective method whose precision may be improved and whose universality may be further investigated.

Of secondary consideration, ascorbic acid as used here is not proven to be consistently effective in preventing loss of eating quality in frozen salmon steaks. Analysis of variance and correlation of ranks are statistical methods employed to adduce more information from these experiments.

80. POINT 4 ACTIVITIES IN FISHERY TECHNOLOGY IN PERU

NORMAN D. JARVIS, Technical Advisor, Fishery Mission to Peru, Office of Foreign Activities, Fish and Wildlife Service, Department of the Interior

Activities include establishment of fishery technological laboratory, selection and training of staff, instruction in examination of all types of fishery products, plant sanitation, product control, fresh fish inspection, food law requirements. Work on improved methods of salting and smoking for warm climates, on freezing fish for local consumption. A three month course in fishery technology, lectures on preparing fresh, frozen, dried, salted, smoked fishery products, fish meal, plant inspection and control, laboratory examination of fishery products, demonstrations and laboratory classes in methods. Program is showing worthwhile results in improving quantity and quality of fishery products thus increasing much needed supply of protein for local diet.

81. SORBIC ACID—A NEW FUNGISTATIC AGENT FOR FOODS

HANS W. VAHLTEICH, Research Laboratories, The Best Foods, Inc., Bayonne, N. J.

Sorbic acid is a C_6 fatty acid containing two conjugated double bonds, one of which is in the alpha position to the carboxyl group. It has the formula CH_3-CH=CH-CH=CH-COOH; the saturated acid is the food fatty acid, caproic acids found in butter oil. Pure sorbic acid is now available in commercial quantities. Objections exist to the use of benzoic acid as a fungistatic agent in foods; these are based upon the low solubility of benzoic acid in water, the necessity for a relatively low pH for activity, limited effectiveness, and the need for detoxification of benzoic acid following ingestion. These objections do not apply to the use of fatty acids containing unsaturation in the alpha position to the carboxyl group; sorbic acid is a member of this group. Contrary to statements in authoritative reference books, sorbic acid is not a component of the fruit of the Mountain Ash (*Sorbus aucuparia*). The alpha unsaturated fatty acids, however, are normal transitory metabolites in the oxidation of the saturated fatty acids by microörganisms and by the animal organism.

82. HARMLESSNESS OF SORBIC ACID AS A FUNGISTATIC COMPONENT OF FOODS

HARRY J. DEUEL, JR., and ROSLYN ALFIN-SLATER, Department of Biochemistry and Nutrition, University of Southern California, School of Medicine, Los Angeles

Sorbic acid, a C_6 fatty acid with conjugated double bonds, has a relatively high LD_{50} value for the rat of about 4.0 g. per Kg. when administered as sodium sorbate. Sodium benzoate has a definitely lower LD_{50} value of about 2.1 g. per Kg. This same relationship favoring sorbic acid has been reported by Smyth and Carrol of the Mellon Institute in both LD_{50} and growth studies with rats. Fatty acids with conjugated double bonds are normally found in all dietary fats. Such fatty acids, including sorbic acid, are not antimetabolites for the essential fatty acids characterized by multiple double bonds not in conjugated positions. Sorbic acid in 5% concentration in fat-free diet does not interfere with growth or efficiency of food utilization but is utilized as a source of calories. The ketonurias of fasting rats fed the sodium salts of sorbic and caproic acid (the naturally occurring C_6 saturated fatty acid) and butyric acid are almost identical in rate of appearance, degree, and in response to concomitant glucose feeding. The simultaneous ingestion of any one of the fatty acids with glucose results in complete metabolism of the fatty acids, yielding carbon dioxide and water as end-products. Alpha unsaturated fatty acids, such as sorbic acid, are normal intermediary compounds in the utilization of the saturated food fatty acids.

83. FATE OF SORBIC ACID APPLIED TO CHEESE WRAPPERS

DANIEL MELNICK, FREDERICK H. LUCKMANN, and C. M. GOODING, Research Laboratories, The Best Foods, Inc., Bayonne, N. J.

A sensitive spectrophotometric procedure has been developed for the determination of sorbic acid in cheese wrappers and in cheese. Tests conducted on a variety of cheese types, blanketing cheese produced as a whole, have shown that the method is specific for sorbic acid in cheese and that added sorbic acid can be quantitatively recovered. Sorbic acid applied on the inner surface of the cheese wrapper migrates rapidly into the cheese in the course of which mold growth is strikingly inhibited. Eventually some mold growth becomes apparent; this coincides with the disappearance of sorbic acid from the cheese. Sorbic acid, a polyunsaturated C_6 fatty acid, is oxidizable by air to form peroxides and aldehydic products of the same type as obtained from the polyunsaturated fatty acids in vegetable oils and in butter oil. Rate of sorbic acid oxidation is of the same order of magnitude noted for the polyunsaturated food fatty acids. In the presence of molds, when the ratio of sorbic acid to mold concentration is very small, oxidation of the fatty acid is catalyzed to a marked degree through the same mechanisms operating in the animal organism, beta-oxidation to the next lower fatty acid homologue of even-number carbon atoms and finally to carbon dioxide and water. Evidence will be presented to show that alpha unsaturated fatty acids undoubtedly act as fungistatic agents in that, as normal transitory metabolites in the oxidation of saturated fatty acids by molds, a "high" initial concentration is capable of inhibiting the dehydrogenase enzyme system in molds.

84. NEED OF THE CHEESE INDUSTRY FOR A HARMLESS FUNGISTATIC AGENT AND THE VALUE OF SORBIC ACID APPLIED TO CHEESE WRAPPERS

DONALD P. SMITH and NORBERT ROLLIN, Dairy Product Packaging Laboratory, Milprint, Inc., West de Pere, Wisconsin

In each of three major divisions of cheese manufacture and distribution, the proper use of a fungistatic agent can prevent loss of product due to mold contamination . . . a minimum of ten million pounds of cheese per year can be so saved. The most widely used and immediately applicable method of protecting cheese products with a fungistatic agent is the incorporation of the fungistatic agent into the wax-coated Cellophane wrapping materials. Sorbic acid, when used in the quantity of 2.0 to 5.0 g. per 1000 sq. in. of wrapper, fulfills the requirements of the cheese industry. The maximal concentration will contribute to cheese less than 0.1% sorbic acid, assuming complete migration of sorbic acid from wrapper into cheese. A concentration of 0.2% of sorbic acid can be added to processed cheese under normal conditions of use without apparent effect on taste, odor, appearance, and physical character of cheese. Calculations based upon (a) the results of toxicological and metabolic studies reported by others, (b) the use of the maximal sorbic acid concentration in treating wrappers, (c) the use of such wrappers in packaging cheese units having the highest ratio of wrapper to cheese, and upon (d) the assumption of complete migration of sorbic acid from wrapper into cheese, and (e) the daily ingestion of a generous 6 oz. of cheese, indicate that the safety factor for the human is more than 200 times.

85. VITAMIN SYNTHESIS OF ACETOBACTER XYLINUM

WARREN LITSKY and C. L. GOLDMAN, Department of Bacteriology and Public Health, University of Massachusetts, Amherst, Mass.

A marked relationship has been reported between *Acetobacter suboxydans, A. melanogenum, A. oxydans* and *A. rancens*, insofar as their vitamin requirements are concerned. Pantothenic acid, p-aminobenzoic acid, and niacin are required by all the cultures of the 4 species. Thiamin has been reported as an additional growth requirement for *A. melanogenum* and *A. rancens*, while biotin was found to furnish an essential factor for the growth of *A. suboxydans*.

In the studies reported herewith, *A. xylinum* was found to require only p-aminobenzoic acid for maximum growth in a synthetic medium containing casein as a source of amino acids. In the light of the above reported work, the vitamin synthesis of *A. xylinum* was studied in order to determine whether or not the above vitamins are associated with this organism. It was found that *A. xylinum* synthesized approximately 6.3 milligamma pantothenic acid, 0.4 milligamma biotin and 90 milligamma niacin per milliliter of medium, after 48 hours incubation at 30°C. in the synthetic medium. Among other things, this work suggests that if *A. xylinum* is incorporated into a vinegar generator, the only added vitamin essential is p-aminobenzoic acid. The remaining vitamins may be synthesized by *A. xylinum*.

86. COLORIMETRIC METHOD FOR DETECTION OF MICROBIOLOGICAL SPOILAGE IN CITRUS JUICES

E. C. HILL, F. W. WENZEL, and ALBERT BARRETO, Florida Citrus Experiment Station, Lake Alfred, Fla.

Off-flavors in citrus juices and concentrates may result from the growth of acid-tolerant bacteria, such as *Lactobacillus* or *Leuconostoc*. A rapid colorimetric method has been developed for the detection of this type of spoilage in citrus products, prior to, during, or after processing. The method, an application of the Voges-Proskauer reaction, is based on the detection of acetylmethylcarbinol or diacetyl, these substances being end products of bacterial metabolism. Comparison is made of the colorimetric method with organoleptic tests as a means of detecting spoilage in citrus products.

87. INFLUENCE OF PLANT HORMONES ON HEAT RESISTANT BACTERIAL SPORES

G. D. LABAW and N. W. DESROSIER, Purdue University Lafayette, Indiana

Studies were carried out to ascertain the influence of synthetic plant auxins on the heat resistance of bacterial spores. It was shown that the heat resistance of spores was markedly reduced in the presence of dilute concentrations of auxins and auxin-like materials.

88. OBSERVATIONS ON THE THERMAL RESISTANCE OF PUTREFACTIVE ANAEROBE NO. 3679 SPORES IN THE TEMPERATURE RANGE OF 250° TO 300° F.

I. J. PFLUG and W. B. ESSELEN, Department of Agricultural Engineering and Food Technology, University of Massachusetts, Amherst, Massachusetts

By means of an apparatus developed in this laboratory, studies on the thermal resistance of bacterial spores at temperatures up to 300° F. have been carried on. A straight line thermal death time curve for P. A. 3679 spores heated in neutral phosphate buffer was obtained in the temperature range of 235° to 300° F. For concentrations of P. A. 3679 spores of approximately 120, 10,000, and 1,000,000 spores in 0.01 ml. amounts of neutral phosphate, the D values were in good agreement when determined at temperatures of 265° to 285° F. The effect of the number of replicate samples run at each time interval on the ultimate results obtained is considered on a basis of data obtained using 6, 24, and 48 replicates.

88A. DETERMINATION OF THE LETHALITY OF BAKING AND COOKING PROCEDURES FOR THE DESTRUCTION OF FOOD CONTAMINATING MICROORGANISMS

ARTHUR M. KAPLAN and HOWARD REYNOLDS, Bureau of Human Nutrition and Home Economics, Agricultural Research Administration, United States Department of Agriculture, Washington 25, D. C.

It has recently been suggested that, as is the case with trichinae in pork, it may be necessary to consider dried egg and dried egg white as potential carriers of viable *Salmonella*, with safety in their use dependent on preparation methods that will assure destruction of these organisms when present. The adequacy of baking and cooking procedures for the destruction of specific infectious or food poisoning organisms can be determined by recovery tests on inoculated and cooked preparations or by the collection and analysis of heat penetration data. The latter approach is much more versatile. Once adequate heat penetration data have been obtained for a defined product and procedure, application of the general methods developed for the analysis of canning processes permits estimation of the lethal value of the cook. Lethality can be evaluated both with respect to organisms whose thermal resistance characteristics have been defined or may be determined or revised in the future.

Using baked custard prepared with dried whole egg as an example, heating and cooling curves and methods for estimating the lethal value of the cook are presented. When custards were baked for 40 minutes at an oven temperature of 340° F., the total lethal value of the heating and cooling periods, evaluated in terms of an organism whose thermal death time curve has a slope value of $z = 12$, was equivalent to approximately 17 minutes at 172° F., the maximum temperature attained during baking. Since this represents a lethality much greater than would be required to destroy organisms having the maximum resistance that has been reported for *Salmonella*, it can be concluded that the accepted method for preparing baked custards will assure a product that will be sterile with respect to such contaminants if present in ingredients.

89. CONTINUOUS HEAT TRANSFER AND PROCESSING IN THE FOOD INDUSTRY

JOHN P. BOLANOWSKI, Girdler Corp., Louisville, Ky.

This paper relates to a heat exchanger of special design and discusses its use in the food industry. The apparatus has been proved to be ideally suited for applications where the materials are heat sensitive, very viscous and undergo a change of state during heating, cooling and agitation. Its application in the continuous cooking, cooling, pasteurization, sterilization, crystallization, emulsification, aerating, mixing and extrusion of food products is given. The apparatus makes possible continuous heating and/or cooling while agitating of many products under rigidly controlled conditions of temperature, pressure, and agitation. The over-all coefficient or rates of heat transfer in this apparatus are from 6 to 10 times higher than those of any other known heat exchange mechanism when processing viscous materials. Details of the continuous film removal from the heat transfer surface within the heat exchanger are described along with operational data covering its application in processing custard, salad dressing, cream soup, chocolate milk, sweetened condensed milk, cake batter, wafer batter, marshmallow, starch jellies, peanut butter, lard, shortening, margarine, concentrated fruit juices, purees, baby foods and similar products.

90. FLAVOR EVALUATION OF CANNED CLING PEACHES

SHERMAN LEONARD, BOR SHIUN LUH, and ELLY HINREINER, Department of Food Technology, University of California, Davis, California

An attempt is being made to correlate one or more analyzable chemical or physical properties of cling peaches, such as sugar-acid ratio, volatile reducing substances or color with flavor of the canned fruit as evaluated by organoleptic methods. Such an objective analytical procedure, particularly one that is applicable to the raw fruit, would be of considerable value to the canning industry in improving the quality of canned cling peaches.

For the past 2 seasons Halford and Gaume varieties of cling peaches grown in California, have been sorted according to size and maturity and canned under rigidly controlled conditions by

commercial procedures. Samples of each lot were analyzed for total acid, soluble solids, pH, ascorbic acid, tannin, volatile reducing substances, texture and color before canning. About 60 days after canning, the samples were submitted to panels for organoleptic evaluation. Portions of these same samples were analyzed for chemical and physical properties.

The results of these flavor ratings by taste-test panels have been compared with the chemical and physical analyses and useful correlations are indicated.

91. STEAM BLANCHING OF PEAS

J. W. HOLMQUIST and L. E. CLIFCORN, Research Department, Continental Can Company, Chicago, Illinois

As a result of a 5-year program in cooperation with a large pea canner and equipment manufacturer to investigate the advantages and disadvantages of steam blanching of peas, many significant new facts have been revealed with regard to off-flavors in the final canned product which were previously ascribed to steam blanching. The use of a detergent wash prior to steam blanching has completely eliminated this objection. Bacteriological studies on companion lots of peas using the hot water blanch and the steam blanching method. From a sanitation standpoint, as may be reflected in the occurrence of flat sours in packs of canned peas, this finding has great significance. Studies on the retention of nutrients have shown a significant increase of ascorbic acid content in the final can product over that of conventionally canned peas. Savings of other nutrients were not reflected. Studies in the specific gravity of peas steam blanched and hot water blanched as may be related to conventional quality separation, have been conducted with a result that suggested modifications of the salinity of the quality separating brine can be made to give the same proportional separation of fancy and standard peas.

Although this paper is specifically a discussion of the *pro* and *con* aspects of steam blanching so far as the method is concerned, the equipment phases of this study offer considerable potentiality for commercial adaptation.

92. NEW SARAN FILM APPLICATIONS IN FOOD PACKAGING

F. J. GIBBS, *Plastics Technical Service*, The Dow Chemical Company, Midland, Michigan

A discussion of the specific properties and applications of saran film applied to food packaging; the use of saran film in laminate form for food packaging; the development of packaging equipment for saran film.

93. INFLUENCE OF NITRATES IN FOODS ON TINPLATE CORROSION

N. H. STRODTZ and R. E. HENRY, Continental Can Co., Chicago, Illinois

The corrosive action toward tin of nitrates, such as are present in some food products, was investigated and found to be greatly dependent upon the pH of the media. The common canning technique of water blanching caused considerable loss of nitrates in the products studied, whereas steam blanching caused little or no loss. The detinning rate of containers packed with green beans was found to be dependent upon nitrate content and pH, but there was reason to believe that a corrosion accelerator other than nitrates was also present.

94. SOME RECENT DEVELOPMENTS IN ALUMINUM FOIL PACKAGING OF FOOD

J. M. FULTZ, Development Laboratory, Reynolds Metals Company, Richmond, Virginia

Discussion is primarily on aluminum foil, but is not limited to aluminum foil as the free metal. It takes aluminum foil and shows some of the combinations with plastic films and papers that have been made and what the specific properties of these various combinations are. Several of these combinations have proved satisfactory for certain types of gas packaging and certain types of packaging requiring sterilization; some of the combinations have good antimycotic properties. The research and development work is brought out. Protective coatings used in conjunction with aluminum foil are discussed generally, in order to show certain specific functions of a number of the coatings used.

95. THE ECO PACKAGING SYSTEM

T. LOUIS JOHNSON, Alfred Hofmann and Company, West New York, New Jersey

This paper discusses The Eco Packaging System, which makes use of an airtight and perfectly siftproof container, and which, by a suitable composition of materials, can also be made impervious to moisture vapor transmission. Results of recent experiments carried out with regard to various plastic coatings suitable for handling heavy liquids such as syrup and oils are incorporated. An explanatory film of machinery suitable for this system will be shown.

96. A NON-DESTRUCTIVE METHOD FOR DETERMINING MICRO LEAKAGE IN COMMERCIAL GLASS CONTAINERS

DAVE EOLKIN, Gerber Products Company, Oakland, Calif.

High voltage gaseous discharge phenomena were employed for the measurement of vacuum levels in commercial glass containers. The method described is non-destructive and is especially adaptable to relatively rapid, accurate determination of gas leakage rates.

The measurements are made by (1) capping at precisely known vacuum levels, (2) periodically determining glow extinction voltages and (3) comparing the data with known standards. Time vacuum changes of less than 1 mm. are easily determinable.

96A. A PRACTICAL CONTROL PROGRAM FOR SHIPPING CONTAINERS

F. A. BROWN, L. J. HAYHURST, and C. W. KAUFMAN, Kraft Foods Company, Research Laboratories, Glenview, Illinois

This paper expounds the development and resulting benefits of a practical control program for shipping containers by a large food company.

The program described in this paper is the result of staffing and equipping a package research group which undertook an investigation to determine whether or not the most efficient packaging mediums were being employed and, if not, to re-design and obtain those materials most suitable from a cost and performance standpoint.

The highlights of this paper include: the findings that showed the necessity for a control program; the testing methods and procedures developed for this program; the education and training of personnel to conduct the testing at various plants; the procedures employed to minimize the percentage of error; and the benefits derived from the control program.

97. DEHYDRATED GREEN BEANS

EARL M. LITWILLER, Oregon State College, Corvallis, Ore.

The need of the Armed Forces for satisfactory dehydrated green beans brought the request to develop a method of dehydrating bush and pole varieties of green beans which will provide a product that will rehydrate satisfactorily and remain acceptable for a period of 6 months at 100° F. After numerous preliminary trials a method which involves prefreezing of the beans was adopted and beans of several varieties and sizes were dehydrated and placed in storage under variable conditions of atmosphere and temperature. Tests at regular intervals to determine which factors may influence quality were conducted.

The results of almost 2 years' work indicate:

(1) It is possible by the prefreeze dehydration process to produce beans which will rehydrate to yield a product which closely resembles a canned bean of the same variety.

(2) The dehydrated material keeps well for a period of a year or longer at room temperatures. At 100° F. there is some deterioration, but inconclusive results indicate they probably will be acceptable after 6 months at this temperature.

(3) Our taste panel finds the best samples very acceptable in flavor and texture.

(4) Improvement in the techniques of cooking dehydrated beans is necessary and progress is being made in this direction.

Further work is planned for adapting the method to commercial scale operation and for securing a large quantity of dehydrated beans for Army trials. Additional experiments to improve the cooking and rehydration procedures will be conducted.

98. EFFECT OF PROCESSING CONDITIONS ON MOISTURE RETENTION BY DEHYDRATED PEAS AND SNAP BEANS

D. B. HAND, J. C. MOYER, and A. C. WAGENKNECHT, New York Agricultural Experiment Station, Geneva, New York

It has long been known that a low moisture content in dehydrated foods is essential to stability during storage. Experiments on both peas and snap beans have shown that the desirable moisture contents are lower than can be obtained by conventional air drying. As air drying proceeds, there is a continuous retardation of the rate, and drying practically stops before the water is completely removed. The slower the drying process, the higher will be the final moisture content. This retardation does not occur if fresh frozen peas are dried under vacuum. However, any partial drying in an air dryer causes changes to occur in the product which prevent complete drying in a freeze dryer. The conditions of air drying, bin drying, and in-package desiccation needed for the production of low moisture dehydrated snap beans and peas are reported.

99. DEHYDRATION OF POTATO GRANULES BY THE MIXBACK PROCESS

A. M. COOLEY and D. E. SEVERSON, University of North Dakota, Grand Forks, North Dakota

Results of a pilot plant study of manufacturing methods on the quality and properties of potato granules made by the mixback process are reported. The effects of changing of process variables upon the quality of the product have been determined quantitatively by means of a texture test for the reconstituted material. The evaluation of the texture of the mashed potato may be done by determining the viscosity by use of the Brookfield viscometer and helipath stand. The effects of dry solids content of the raw material, mixing time, aging time, degree of cell fracture and conditions of drying upon the texture are studied. Rates of drying of the powder were determined in a pneumatic type dryer.

100. DRYING PROBLEMS IN THE ADD-BACK PROCESS FOR PRODUCTION OF POTATO GRANULES

G. H. NEEL, G. S. SMITH, M. W. COLE, R. L. OLSON, and W. O. HARRINGTON, Western Regional Research Laboratory, BAIC, USDA, Albany, California

The add-back process for commercial production of potato granules involves mixing freshly cooked potato with previously dried granules to obtain a friable mixture that is subsequently granulated and dried. Throughout the process mechanical damage to potato cells should be avoided in order to minimize release of free starch which causes pastiness in the reconstituted product. The occurrence of mechanical damage during pneumatic drying is discussed. Study of damage in the drying operation is complicated by the fact that damage occuring in each pass through the primary drying system is cumulative, since the granules are recycled repeatedly before being finish-dried and packed as product. Factors felt to be of potential importance in relation to abrasion and impact damage in pneumatic driers are indicated, and difficulties involved in determining the effects of these factors are outlined.

Studies are under way on 2 experimental driers designed specifically for drying potato granules with minimum mechanical damage. One is an air-lift drier for use in primary drying and the other is a fluidized-bed drier for use in finish drying operations. The fluidized-bed drier is practical for drying potato granules to moisture contents below military specification level. Both driers are briefly described and results obtained in preliminary drying experiments are outlined.

101. DEVELOPMENT AND EVALUATION OF POTATO CHIP BARS

R. H. TREADWAY, C. F. WOODWARD, E. G. HEISLER, Eastern Regional Research Lab., BAIC, USDA, Philadelphia, Pa.; and J. R. WAGNER, R. M. HOPKINS, Quartermaster Food and Container Institute, Chicago, Illinois

Potato chips are a popular item among the predominant age groups in the Armed Forces. Potato chips as such could not be considered for issue as a ration, however, because of their excessive space requirements and difficulties of packaging. In cooperation with Eastern Regional Research Laboratory, it was found that crumbled chips can be pressed into a bar that will occupy a volume only about one-twentieth of the original packaging volume. Bars pressed from potato chips fried in hydrogenated vegetable shortening, to which has been added an antioxidant preparation of butyl hydrozyanisole propyl gallate and citric acid in propylene glycol were found to have excellent performance characteristics in terms of military requirements for acceptability, nutritional properties, storage life and convenience of use.

102. INFLUENCE OF PIECE SIZE ON PRODUCTION AND QUALITY OF DEHYDRATED IRISH POTATOES

M. SIMONS and J. R. WAGNER, Quartermaster Food and Container Institute, and V. G. SILVEIRA and C. E. HENDEL, Western Regional Research Laboratory, BAIC, USDA, Albany, Calif.

A study has been made of the effects of piece size and shape, and of calcium chloride treatment on preparational losses, drying time, bulk density, rehydration rate, and relative preference values of dehydrated Irish potatoes. With the Idaho Russet Burbank potatoes employed in this study, the use of calcium chloride for firming made it possible to produce dehydrated potatoes of desired thickness ($\frac{1}{8}$ inch) which did not slough or become mushy during rehydration and cooking. Calcium chloride treated potatoes of $\frac{1}{8}$ inch thickness had the desirable properties of dehydrating more rapidly and to lower moisture content within practicable time than did untreated potatoes of $\frac{3}{16}$ inch thickness (present military requirement). Preference studies showed that for the dehydrated potatoes produced in this investigation, the calcium chloride treated samples of $\frac{1}{8}$ inch thickness were at least as acceptable as those of military specification size requirements, when employed in a variety of recipe items.

103. EFFECT OF PROCESSING VARIABLES ON STORAGE STABILITY OF DEHYDRATED SWEETPOTATOES

F. E. LINDQUIST, M. P. MASURE, W. C. DIETRICH, and MARVEL-DARE NUTTING, Western Regional Research Laboratory, BAIC, USDA, Albany, California

The effect of storage atmosphere and temperature and moisture content on the stability of dehydrated sweetpotato dice was investigated. Pre-drying treatments included (1) blanching only, (2) blanching plus sulfiting, and (3) blanching plus starch coating. Samples at 4.4 and 7.5% moisture were packaged in air and in nitrogen and stored at elevated temperature. Particular emphasis was placed on materials stored at 100° F., since minimum requirements of the Quartermaster Corps for dehydrated products demand acceptability after 6 months' storage at this temperature. Subjective evaluations of high-moisture samples stored 6 months at 100° F. and of high and low moisture samples stored 7 months at the same temperature were made by means of the balanced incomplete block design. Results showed that, in general, sulfited samples packed in air or nitrogen were scored better in flavor than the other samples. Starch coating offered no advantage in flavor over blanching alone. Low-moisture samples were scored better in flavor under all conditions of processing and storage. Very few significant differences in color were noted between samples either by subjective evaluation or by objective analyses, soluble color, and reflectance color. Addition of butylated hydroxyanisole (50 p.p.m.) or propylene oxide (0.01 and 0.1%) to samples showed no particular stabilizing effects.

104. PROCESSING REQUIREMENTS FOR CANNED STERILE WHOLE MILK

WILLIAM J. BIEHL, President International Milk Processors, Inc., Chicago, Illinois

Dairy scientists for years have been attempting to develop a process for canning whole milk which would retain its fine fresh taste when opened. The complexity of the chemical composite of milk and the wide range of variations in the physical qualities in milk presented innumerable problems.

Cumulating these years of research is a process which, under the most rigid controls, produces a fresh-tasting, sterile, whole canned milk which can be stored upwards to one year without

refrigeration. This process, which has been used commercially for more than 2 years, embodies close control of many variables in the production of canned milk from the time the milk leaves the cow until it is finally sealed in the can. This paper covers the basic requirements of the raw milk, the quality controls needed in all phases of the operation, the mechanical controls employed in the process, and the new type of processing equipment which has been found to be essential in the successful production of canned sterile whole milk.

105. RESISTANCE OF BACTERIAL SPORES TO GAMMA IRRADIATION

JAMES M. REED and BRUCE H. MORGAN, National Canners Association, Washington, D. C.

Process determination in present day heat sterilization of canned foods is based on a knowledge of the heat resistance of spoilage organisms. Since the spore is the most resistant form of these organisms to the action of both heat and irradiation, the achievement of sterility by an irradiation process must also be based on spore resistance.

To this end, suspensions of spores that are of interest to the canning industry have been subjected to gamma irradiation. These suspensions included 2 strains of *Clostridium botulinum*, as well as representatives of the flat-sour group, putrefactive anaerobes and thermophilic anaerobes. The resistance of these organisms to gamma irradiation does not appear to be constant but rather varies as do the conditions prior to, and during, irradiation. This paper discusses these factors as well as the effect on spore survival of combinations of the 2 sterilizing methods, heat and photon bombardment.

106. COMPARATIVE BACTERICIDAL EFFECTS OF THREE TYPES OF HIGH-ENERGY IONIZING RADIATIONS

S. A. GOLDBLITH, B. E. PROCTOR, S. DAVISON, B. KAN, D. A. LANG, C. J. BATES, M. KAREL, and E. M. OBERLE, Department of Food Technology, Massachusetts Institute of Technology, Cambridge, Massachusetts

Within the past 2 years the U. S. Atomic Energy Commission has announced the possible availability of radioactive by-products of atomic fission for sterilization purposes. Concurrently with this announcement, the Commission made available kilocurie sources of Cobalt-60, in order that studies might be begun on the effects of gamma radiations of well-defined high-energy levels (such as are obtained from Cobalt-60) on microorganisms.

The Department of Food Technology, Massachusetts Institute of Technology, installed, calibrated, and has been using a kilocurie Cobalt-60 source since February 1952 for research on the potential use of isotopic radiations for sterilization of foods, drugs, and pharmaceuticals. One phase of this research has been a study of the bactericidal effects of the gamma radiations from Cobalt-60.

As most of the data in the literature on the bactericidal effects of ionizing radiations are based on research done with cathode rays (electrons), an intensive study has been undertaken in these laboratories to compare the effects, on microorganisms, of high-energy X-rays and cathode rays produced by a particle accelerator and of γ-rays from the isotopic Cobalt-60 source. Such comparisons should enable, for the first time, evaluation of comparable lethal dose rates of the 3 types of radiation. A comparison is presented of the results obtained on a large number of samples of a spore-forming and of a non-spore-forming organism when exposed to the 3 sources of radiation.

107. SMITH-BALL PRESSURE CANNING PROCESS

HORACE L. SMITH, JR., Richmond, Virginia, and C. OLIN BALL, New Brunswick, New Jersey, *Consultants*

In heat processing foods of low acid content in cans, for sterilization, the theme of technic modification to effect quality improvement of the product over that obtained in conventional methods of processing is "Reduce the length of the period of heating." The possibility of achieving results by reducing the period of heating depends on the influence of 3 factors; namely, (1) rise of processing temperature, (2) acceleration of heat penetration, (3) reduction in concentration of spoilage microorganisms in the food entering the can.

A process, known as the Smith-Ball process, was developed by Horace L. Smith, Jr. and C. Olin Ball, of Food Processes, Inc., Richmond, Virginia and the first commercial unit of the process was installed by La Choy Division, Beatrice Foods Company, Archbold, Ohio, for use in producing chop suey in 48-ounce cans.

Under usual methods of processing, the quality of chop suey suffers greatly through heat sterilization; since the larger the can, the longer must be the heating period, the impairment of quality suffered by the product is proportional to the size of the can. The effect of heat is so great that it is not feasible by conventional methods to pack chop suey in cans holding more than 20 ounces.

The Smith-Ball process figuratively places the canning plant in a location of greater atmospheric pressure than that found on the surface of the earth. It is as if the plant were located in the bottom of a canyon almost 10 times as deep as the Grand Canyon, or, somewhat more than 1½ times as deep as Mt. Everest is high. Atmospheric pressure at the canning line is 2 pounds p.s.i. greater than the atmospheric pressure of the usual canning plant. Under this high atmospheric pressure, it is possible to seal food in cans when the food is at a temperature of 250°-255° F.

The necessary conditions for the canning operations of this process are provided in a steel room in which conventional filling and closing machines are operated by attendants. Essentially the process consists of the following operational steps:

(a) In a product heater which is separate from the steel canning room, heating the product very quickly and uniformly by means of live steam under high pressure to a temperature of from 280° to 320° F.

(b) Discharging the product from the heater and quickly cooling the product to from 250° to 255° F.

(c) Filling the product into cans which have been previously subjected to live steam under 20 pounds gauge pressure for sterilization.

(d) Sealing the cans with covers which have been previously subjected to live steam under 20 pounds gauge pressure for sterilization.

(e) Holding the sealed cans of food before cooling for a sufficient length of time to effect destruction of any occasional microorganisms which might have been viable in the food at the time of filling, regardless of whether these microorganisms are the residue of the organisms originally present in the raw product or are contaminants which enter during filling.

(f) Cooling the cans.

108. EFFECT OF FREEZING, SULPHURING AND STORAGE CONDITIONS ON THE QUALITY OF DEHYDRATED SWEET CORN

R. G. TISCHER and E. W. JERGER, Iowa State College, Ames, Iowa

The chief variety of yellow sweet corn was used in a comparison of sulphur treatment versus no-sulphur treatment to determine the effect on the quality of the dehydrated product. Experienced judges were used to determine 5 attributes of quality of the rehydrated product. The effect of freezing and duration of frozen storage on fresh corn was investigated. Results show a marked effect of sulphur treatment in preserving quality which is similar in both dehydrated fresh and frozen corn. Frozen storage up to 9 months exhibits little effect on the dehydration characteristics suggesting that frozen corn may be used throughout the year in research on dehydration to yield results generally applicable to fresh corn.

109. STUDIES ON THE DEHYDRATION OF SWEET CORN

A. I. NELSON, L. L. KEMPE, H. W. NORTON, and L. B. HOWARD, University of Illinois, Urbana, Illinois

An experiment is described which covers the variables of preparation, dehydration and storage of dehydrated sweet corn. A fractionally replicated design involving the effects of eight variables was used. Blanching by water or steam at several time intervals was applied both to cut corn and corn on the cob. Dehydration by thru flow and by cross-tray flow was carried out with wet- and dry-bulb schedules that could be adapted to commercial operation. Dehydrated product at different moisture levels was stored under both nitrogen and air at 4 temperature levels for 6 weeks, and the resultant samples were evaluated by subjective and objective methods. Sulfite level, storage temperature, and storage time exerted by far the greatest influence on the acceptability of the dehydrated product.

110. IN-PACKAGE DESICCATION OF DEHYDRATED FOODS

C. E. HENDEL, Western Regional Research Laboratory, BAIC, USDA, Albany, California

In-package desiccation, a process for drying a product, or for maintaining its dryness, during storage, consists of packing with the product a suitable desiccant enclosed in a moisture-permeable container. Extensive studies at the Western Regional Research Laboratory during World War II showed that by this process the browning of dehydrated vegetables during warm storage can be effectively controlled. A military specification for in-package desiccation was issued in 1945, but has not been used for regular procurements. From a number of potential desiccants, reactive calcium oxide was selected as the most favorable for dehydrated fruit and vegetable products where it is desired to reduce the moisture content to a very low value with minimum sacrifice of container volume. Recent investigations indicate the probable feasibility of a less expensive desiccant container than the jeancloth bag with kraft paper liner formerly recommended. A commercially-available two-way-stretch paper with a heat-sealing coating appears to have the mechanical properties and water vapor permeability required. The effects of the various components of the package on the rate of desiccation have been studied, the effect of each component being expressed in terms of a "transfer coefficient." The transfer coefficients have been determined for 3 dehydrated vegetables, for the package atmosphere (air), for 3 potential desiccant container materials, and for 2 active calcium oxides.

111. STABILIZATION OF DEHYDRATED CABBAGE BY IN-PACKAGE DESICCATION

H. K. BURR and V. G. SILVEIRA, Western Regional Research Laboratory, BAIC, USDA, Albany, California

In-package desiccation was developed and extensively studied at the Western Regional Research Laboratory during World War II, and was shown to be an effective means of stabilizing dehydrated vegetables, including cabbage. Essentially it consists of packing a desiccant with the product in order to reduce its moisture content to a very low level. The present study was designed to demonstrate the effectiveness of this process with commercially available dehydrated sulfited cabbage of a quality suitable for use in cole slaw, and to test a montmorillonite desiccant as well as the calcium oxide previously recommended. All samples were packed in No. 10 cans, the size now used for military procurements of dehydrated vegetables, and stored 1 month at room temperature, followed by 6 months at 100° F. Data were obtained periodically on moisture content, soluble color (nonenzymatic browning), and rehydration ratio. At the end of storage, sulfite contents were determined and the flavor and color of rehydrated samples appraised organoleptically. Lime was found to be a more efficient desiccant than the montmorillonite under the conditions of the experiment; but even of the latter, 6 oz., occupying about 7% of the volume of the can, was very effective in maintaining quality. A new rehydration test for cabbage is described. The relationships between the equilibrium moisture contents of the montmorillonite and dehydrated cabbage were determined at 100° and 75° F. From these can be estimated the amount of montmorillonite needed to reduce the moisture content of cabbage to a given level.

112. COMPARISON OF MEDIA FOR ENUMERATION OF BACTERIAL POPULATIONS IN DEHYDRATED VEGETABLES

ROBERT M. MARTHINSEN and REESE H. VAUGHN, Deparment of Food Technology, University of California, Davis, California

Possible use of microörganisms as indices for quality of dehydrated vegetables as suggested by Vaughn, *Food Research, 16*, 429, 1951, was investigated. Differential media for coliform bacteria (Eosine methylene blue agar), lactic acid bacteria (sorbic acid and Rogosa's medium) and conventional media for thermophilic bacteria were included in the study. Media for comparison of "total" aerobic counts included Bacto dextrose tryptone agar and an experimental dehydrated orange serum agar (samples from Sunkist Growers and Difco). The dehydrated vegetables included weekly composite samples of onions and potatoes in the western states plus certain "grab" samples of dehydrated cabbage, carrots, celery, green and red bell peppers, and parsley.

Variations in "total" counts were slight, regardless of the medium. Thermophilic bacteria ("total" aerobic and anaerobic thermophiles including "flat-sour", gas-forming anaerobes, and "sulfide stinker" types) comprised an insignificant portion of the "total" population, regardless of the kind of dehydrated vegetable. In contrast, the majority of the "total" population was generally composed of coliform bacteria of the genus *Aerobacter*. However, there were a few samples where lactic acid bacteria equalled or surpassed the coliform counts.

113. DEHYDRATION OF CLING STONE PEACHES

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Studies have been made on the relation of pretreatment drying conditions, packaging and storage conditions to acceptability and vitamin retention of dehydrated cling stone peaches. Halford, Levy, Palora, Stuart and Tudor varieties have been used in this study although Halford was used most. Dehydration procedures used included the counter-current operation at 3 finishing temperatures 150°, 160°, and 170° F.), two-stage and constant temperature. Lots were dried to 3 moisture contents (18%, 22%, and 26%). Observations have been made on storage life, acceptability and vitamin retention as related to the foregoing factors.

114. PRODUCTION OF STABLE DEHYDRATED ORANGE JUICE

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Studies at the Western Regional Research Laboratory have resulted in the development of a powder prepared from orange juice which possesses extremely good storage characteristics even at elevated temperatures. It reconstitutes readily into a very palatable beverage upon addition of water. Thus for the first time, a product with sufficient storage stability to meet the requirements for domestic or military use has been prepared.

The process for the new produce employs concentrated orange juice similar to that used for commercially packed frozen concentrates as a starting raw material. To this concentrate are added some low-conversion corn sirup solids to reduce hygroscopicity of the final product. This mixture is then vacuum dried at moderately low pressures; the more expensive high-vacuum or "freeze-drying" process is unnecessary. The evacuation is conducted in such a way that the concentrate expands or "puffs" during drying. The resulting open structure makes it possible to dry the material rapidly and at a sufficiently low temperature so that flavor changes are not significant. Powder prepared by crushing the dried material to suitable size still retains the porous open structure, which permits rapid reconstitution with water. Comminuting to the proper particle size is an important part of the process, since reconstitution becomes much more difficult when the material is reduced to a very fine powder.

The original orange flavor, largely lost during dehydration, is replaced by addition of a small amount of specially prepared natural orange oil to the powder. This orange oil is first in-contact of the oil with oxygen and thus to minimize flavor corporated in a small amount of edible solid carrier to prevent changes in the oil during storage.

The orange powder has a storage life in excess of 6 months at 100° F., and one year at 70° F. with little change in vitamin C content and only minor losses of carotene (pro-vitamin A). Deterioration at 70° F. temperature is very slow. This excellent stability is achieved in large measure through use of a packet of desiccant in each sealed can of powder to remove substantially all remaining moisture (several per cent) from the powder after it has been packaged.

Does Pepper Contribute to Food Preference?[a]

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(Manuscript received October 18, 1952)

The effect of omitting pepper from certain foods is explored. Results of a comparison of natural pepper with imitation pepper are also reported.

Natural pepper became short in supply early in World War II when we were cut off from East Indian sources. Since the war the situation has improved somewhat, but natural pepper is still scarce and prices have remained high. During the war imitation peppers were introduced on the market and enjoyed a certain degree of success. In recent years the use of imitation peppers has increased rather than decreased until they are definitely a factor in the spice market. Also their potential importance to the food processing industries must be considered.

Imitation peppers appearing on the market have been highly variable in quality and it is probable that no formulation has been identical in flavor with natural pepper. This has emphasized the need for a method of evaluating imitation formulations both for their own flavor and for their effects on the flavor of foods.

Military interest in imitation peppers developed initially in relation to the problem of determining whether or not to stockpile natural pepper as a strategic material and also because of the difficulty of procuring the natural spice in sufficient quantity and the potential economic advantage of using the cheaper material. In 1948 the Qm. Institute initiated work on imitation peppers and pepper substitutes. During 1949 a method of evaluating imitations by sensory tests involving comparison with natural pepper was established *(1)*. Available commercial imitations and a wide variety of experimental formulations were tested by this method. Every one was found to be definitely different from natural pepper in one or more aspects of flavor.

This work led to investigation of the basic importance of pepper as an improver of food flavors. Preliminary studies showed that pepper could be omitted from many foods where it is normally used with no loss of consumer preference and this finding suggested a reorientation of our work. If natural pepper has little effect on food flavors as measured by consumer preference, the imitation pepper problem becomes less important. Then the consumer preference criterion would not be applicable and standards of performance for imitation peppers could be relaxed or else redefined.

[a] This paper reports research undertaken for the Quartermaster Food and Container Institute for the Armed Forces, and has been assigned number 400 in the series of papers approved for publication. The views or conclusions contained in this report are those of the authors. They are not to be construed as necessarily reflecting the views or indorsement of the Department of Defense.

[b] Presented before the Twelfth Annual Meeting of the IFT, June 12, 1952.

MATERIALS AND METHODS

The effect of pepper was studied only in foods where precedent would lead one to expect some beneficial effect. The foods tested were either processed items used in military rations or items prepared from recipes in the *Army Cook Book*. Pepper was required in each one either by recipe or by military specification. Foods were selected to include representatives of a number of food classes, including: soups, salads, vegetables, and processed meats. Emphasis was given to soups and canned meats on the basis of the results of a questionnaire submitted to representatives of the spice and food processing industries in 1949 since the respondents uniformly agreed that pepper is indispensable in such foods.

Flavor improvement was defined in terms of consumer preference. A food containing natural pepper at a certain concentration was compared with the same item prepared identically except that a flavorless pepper base was substituted for the pepper. The criterion of flavor improvement was a significant preference for the food containing pepper.

Two types of testing were employed:

(a) Difference testing by the triangle method using a trained panel in order to determine whether or not pepper caused a flavor change and to estimate the amount of change.

(b) Paired-comparison preference tests, using laboratory consumer groups drawn from among approximately 450 employees available within the Chicago Quartermaster Depot. The composition of the consumer groups varied randomly from day to day and both sexes were included. One-ounce samples of the 2 foods were presented simultaneously to the observer who was instructed to eat both and then indicate his preference. Each observer normally tried 2 pairs at a single test session, either repeating the test on a single pair or testing 2 pairs representing different concentrations of pepper in the same food.

The method of determining the concentration, or concentrations, of pepper to be tested on preference varied according to the accuracy of information available as to the use of pepper in the particular food. Three different situations were encountered:

(a) *Processed items covered by military or industrial specifications.* The only pepper concentration tested was that given in the specification. Items with and without pepper were processed in parallel, the work being done either at the Institute or in cooperating industrial laboratories. Each "pepper" item was first tested for flavor difference against its "no-pepper" standard. If a difference was established, the pair was tested on consumer preference.

(b) *Recipes stating a definite concentration of pepper.* The recipe concentration was tested for difference against the "no-pepper" food by the trained panel. If no definite flavor difference was found, the pepper concentration was increased to the point where approximately 67% correct responses were obtained on the triangle tests. This level was then tested on consumer preference against the "no-pepper" standard. If no definite preference was established but a trend toward preference for the "pepper" food appeared, the pepper level was adjusted upward or downward as required to determine whether the trend would become significant. Preference testing of an item was terminated whenever preference for the sample containing pepper had been established or when it was apparent that the testing of additional levels was unlikely to result in any increased preference.

(c) *Recipes stating "pepper to taste."* The initial level for testing was determined by the judgment of trained home economists, and testing proceeded as in (b) above.

For foods where preference for the sample containing pepper was established, or where a trend in that direction was found, the investigation was extended to determine whether imitation pepper might have the same beneficial effect. Each food was prepared both with natural pepper and with imitation pepper at the optimum concentration and the two were compared on preference. The particular imitation pepper used was selected as meeting *2* criteria: (a) it was represented by its manufacturer as containing only domestically available materials and (b) it was closer to natural pepper in flavor, as determined by sensory testing in the laboratory, than any other imitation pepper which met the first criterion.

RESULTS

The results of the paired-preference comparisons for all of the foods tested are given in Table 1. Where tests on several concentrations were run, only the result showing the highest preference for the food containing pepper is shown. Pepper concentration is given as percent by weight of the food prior to cooking or processing where these steps were necessary as, for example, in soups or processed meats. When no cooking was involved, the pepper was added just before serving. The number of preference responses varied from 78 to 122 and no one made any given comparison more than twice.

The percentage preference for the "pepper" sample is shown and is evaluated in the last column. In the paired-preference test each sample would get 50% of the choices by chance alone if there were no preference for either sample. All differences between the obtained result and the chance result significant below the 10% level of confidence are shown even though the latter can be regarded only as a slight trend.

Of the 31 foods and recipes tested, the addition of pepper increased preference in only 5. Only *2* classes were improved: bean, chicken, and vegetable soup all showed increased preference significant at the 1% level of confidence, and preference was increased at the 5% level of confidence in the *2* processed meats—bologna and liver sausage. In addition there were preference trends with pork sausage and fried haddock, but the other 24 foods gave no indication of increased preference. These 7 foods which were either improved by natural pepper or showed a trend toward improvement were studied further to compare the effects of natural pepper and the selected imitation pepper. Table *2* shows that the foods prepared with the *2* peppers were preferentially equal in all cases.

TABLE 1

Results of paired preference comparisons between foods prepared with and without pepper

Foods	Percent Pepper[c]	N	Percentage Preference		Significance of Difference[f]
			With Pepper	Without Pepper	
Processed Meats[a]					
Bologna	0.375	82	62.2	37.8	5%
Frankfurters	0.375	80	52.5	47.5	
Salami	0.344	79	49.4	50.6	
Liver Sausage	0.250	80	61.2	38.8	5%
Beef and Gravy	0.045	80	55.0	45.0	
Corned Beef Hash	0.038	80	42.5	57.5	
Pork Sausage	0.130	122	58.2	41.8	10%
Soups[d]					
Split Pea	0.035	78	42.3	57.7	
Bean	0.048	78	65.4	34.6	1%
Cream of Potato	0.025	80	52.5	47.5	
Cream of Celery	0.031	81	53.1	46.9	
Chicken	0.020	80	66.2	33.8	1%
Bouillon	0.020	74	58.1	41.9	
Cream of Tomato	0.015	60	40.0	60.0	
Vegetable	0.010	80	66.2	33.8	1%
Salads[d]					
Cucumber and Onion	0.028	78	51.3	48.7	
Chopped Vegetable	0.063	80	54.8	45.2	
Potato	0.072	80	55.0	45.0	
Egg	0.100	80	42.5	57.5	
Vegetables[d]					
Lima Beans	0.030	78	53.8	46.2	
Peas	0.030	79	48.1	51.9	
Green Beans	0.030	78	39.7	60.3	
Creamed Carrots	0.020	79	58.2	41.8	
Others[d]					
Hashed Brown Potatoes	0.034	78	55.1	44.9	
Mashed Potatoes	0.040	80	51.2	48.8	
Creamed Chicken	0.030	80	53.8	46.2	
Fried Haddock	0.080	81	60.5	39.5	10%
Scrambled Eggs	0.055	80	58.8	41.2	
Tomato Juice	0.040	60	40.0	60.0	
Meat Loaf	0.303	80	52.5	47.5	
Hamburgers	0.220	60	51.7	48.3	

[a] Pepper concentration determined by Military or Industrial Specifications.
[d] Pepper concentration determined experimentally by adjusting recipes.
[c] Percent pepper by weight prior to cooking or processing. When no cooking was involved, pepper added just before serving.
[f] Level of confidence as determined by the "t" test.

TABLE 2

Comparison of natural pepper with imitation pepper in foods which were improved by natural pepper

Foods	Percentage Pepper[c]	N	Percentage Preference		Significance of Percentage[b]
			Natural	Imitation	
Vegetable Soup	0.010	80	46.0	54.0	
Chicken Soup	0.020	80	55.0	45.0	
Army Bean Soup	0.048	80	56.0	44.0	All results are insignificant
Bologna	0.375	80	41.0	59.0	
Liver Sausage	0.250	80	50.0	50.0	
Pork Sausage	0.130	79	57.0	43.0	
Fried Haddock	0.080	80	45.0	55.0	

[c] Percent pepper by weight prior to cooking or processing. When no cooking was involved, pepper added just before serving.
[b] Level of confidence as determined by the "t" test.

DISCUSSION

The finding of no group preference for either of the *2* samples involved in each comparison might arise in two ways: first, the choices of all observers might be distributed by chance between the "pepper" and "no-pepper" samples, or some observers might actually prefer the "pepper" sample, being counterbalanced by an equal number who prefer the "no-pepper" sample. The frequent occurrence of the latter situation would be significant since it would mean that we were dealing with *2* opposing preference tendencies rather than a "no preference" situation. Since in many of the consumer tests each observer made *2* comparisons, the responses may be analyzed for consistency for an indication of the probable importance of opposite but equal preferences.

Table *3* presents the results of such an analysis for 14 foods where no preference was established and where the observers made duplicate comparisons. Those who chose the same sample each time, either "pepper" or "no-pepper," have been classed as "consistent" and those who chose different samples in the two comparisons have been classed as "inconsistent." If the choices of all observers had been determined by chance alone there would have been an equal number in each class. The significance of the difference between this chance percentage ratio and the observed ratio is shown. In only 3 of the 14 cases is the difference significant at the 5% level of confidence, which suggests that opposite but equal preferences were probably not a major factor.

What do the results of the experiment mean? Certainly they confirm the preliminary finding and lend strong support to the suggestion that the importance of pepper to the flavor of foods has been greatly overemphasized. But when one doubts the efficacy of pepper,

TABLE 3

Consistency of individual preferences for foods with and without pepper when group preference is equal

Foods	Consistent Observers[1]		Inconsistent Observers[2]		Significance of Percentage[3]
	N	%	N	%	
Potato Salad	28	70	12	30	1%
Creamed Carrots	26	68	12	32	5%
Pea Soup	27	66	14	34	5%
Mashed Potatoes	25	63	15	37	
Frankfurters	24	60	16	40	
Scrambled Eggs	23	58	17	42	
Green Beans	22	56	17	44	
Salami	21	54	18	46	
Chopped Vegetable Salad	21	53	19	47	
Cucumber and Onion Salad	19	49	20	51	
Meat Loaf	20	50	20	50	
Fresh Peas	19	49	20	51	
Hashed Brown Potatoes	18	46	21	54	
Luna Beans	17	44	22	56	

[1] Observers who chose either the "pepper" or "no pepper" sample twice in two comparisons.
[2] Observers who chose a different sample in each of the two comparisons.
[3] Level of confidence as determined by the "t" test.

he is challenging a firmly entrenched tradition. Therefore it would be well to keep the record clear by stating what has not been proven.

These results are based on a laboratory technique and the consumers were drawn from the restricted population represented by 450 employees of the Chicago Quartermaster Depot. Quite obviously they could not be considered a satisfactory sample of the whole United States. Even though they were drawn from a metropolitan area and many factors would have been randomized, it is quite possible that other groups of people, possessing other national, regional, or cultural food habits, might have responded differently. Further, only a sampling of the many common foods in which pepper may be used was tested. By chance the experiment may have neglected a significant number of those recipes where pepper is important. Certainly there are many specialty dishes which were not considered. The results are not concerned with individual preferences but only with the group response. Thus, they do not deny the validity of the gourmet's demand for the special flavor quality that only natural pepper can provide. Sometimes it is claimed that the beneficial effects of spices lie as much in preventing monotony of a diet over periods of continued use as in the immediate enhancement of preference. Such long term effects were not investigated.

Once we have clearly expressed the limitations of the data we may seek out their positive implications. These are not negligible. Although the experiment included only 31 foods, they represented several flavor types and were common foods where custom requires the use of pepper. That similar effects would have been found in many other foods is unquestionable. Preference was tested under conditions of laboratory control where any real effect would have been enhanced rather than minimized. The significance of a preference established under such conditions may be denied on the grounds that it is based on factors which would not be noticed under non-laboratory conditions. However, a finding of "no-preference" can not be challenged on the same grounds since one is even more likely to find the same effect under conditions of normal consumption. Further, even though the group from which the observers were drawn cannot be considered representative of the entire American consumer population, one should not overlook the possibility that it is representative of large segments of that population. There is no obvious reason why the flavor preferences of residents of the Chicago area will be different from those of Americans in the mass. The selection processes which brought people, first to the Chicago Quartermaster Depot and then to the laboratory, were not such as to bias any data on food preferences. Thus the results can claim to be somewhat more than suggestion.

No matter how valid the finding that natural pepper is unimportant in determining preference for foods as eaten, the demand for pepper—both by consumers and by food processors in the supposed interests of consumers—is a self-evident fact. Further, there is evidence that imitation peppers have been relatively ineffective in satisfying the demand. This seems inconsistent. How does one explain this demand? The question cannot be answered here but can be put into perspective by reference to the concept of habit. Pepper continues to be in demand in large part because our culture has developed habits of preparing food and eating food wherein pepper is included. For many people pepper may be more important as a symbol than as a flavor. Its removal or its significant alteration as in imitation peppers may affect flavor but little and preferences not at all, but still may violate our sense of propriety.

Research results such as these probably have but little significance in regard to pepper on the direct consumer market. The consumer's habits change quickly only through dire necessity. But the results seem to have at least two important implications for the food processor who may be faced with pepper shortages and high prices. These possibilities are:

(a) that pepper may be entirely omitted from certain foods without loss of consumer acceptance, and

(b) that imitations may be substituted for natural pepper in many other foods without loss of acceptance.

Acknowledgments

The authors gratefully acknowledge the assistance of the laboratories of Swift and Company and the Visking Corporation in preparing the processed meats used in this study. They similarly acknowledge the help received from Mr. Joseph Stukis and Dr. Keith Swartz of the Quartermaster Food and Container Institute in preparing the experimental ration items.

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Effect of Freezing and Freezer Storage Upon Quality of Baked Rolls, Brown-and-Serve Rolls, and Shaped Roll Dough

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(Manuscript received December 15, 1952)

In a study of rolls preserved by freezing it is reported that rolls baked before freezing rate higher than those prepared from fermented shaped dough or rolls of the brown-and-serve type.

Preservation of rolls by freezing has practical and theoretical interest but there is little agreement on which method of preparation will give the best results. This investigation was undertaken in an attempt to evaluate the effects of freezing fermented shaped dough, baked rolls, and brown-and-serve rolls.

Conflicting reports have appeared in the literature on the relative merits of freezing doughs at various stages during preparation. Recommendations have been made for freezing doughs unfermented unshaped *(7, 14)*, unfermented shaped *(4)*, fermented unshaped *(9, 12, 13)*, and fermented shaped *(2, 3, 15)*. Invariably frozen doughs have deteriorated in quality during storage and the changes have been frequently attributed to inactivation of yeast *(1, 3, 4)*. Godkin and Cathcart *(4)* reviewed a number of articles on the viability of moist and dry yeast after freezing and freezer storage. However, little information is available concerning the effect of freezer storage on the action of yeast incorporated into dough.

Fenton *(2)* reported a series of experiments dealing with the freezing of baked rolls and of yeast doughs at different stages during preparation and concluded that baking rolls before freezing resulted in fewer failures. In addition a few workers *(1, 11, 15)* have stated that rolls baked and then frozen could be held satisfactorily in the freezer for longer periods than frozen doughs. A relatively new method for the preservation of rolls, freezing of brown-and-serve rolls, was suggested by Hanley *(5)*. At present, though, there are no reports in the literature on the quality of brown-and-serve rolls after intervals of freezer storage.

In this study the effects of freezing and freezer storage upon the palatability and volume of rolls frozen as fermented shaped dough, brown-and-serve rolls, and baked rolls were investigated. Six replicate batches of each type were compared after 1, 3, 6, and 9 weeks of freezer storage and, in addition, six replicates each of brown-and-serve rolls and of baked rolls were compared after 12 and 15 weeks. Yeast plate counts of viable yeast cells and manometric determinations of gas production were made on the fresh and thawed frozen doughs.

EXPERIMENTAL PROCEDURE

Preparation of rolls. Rolls were prepared according to the following formula: 360 ml. milk, 75 g. sugar, 15 g. salt, 82 g. hydrogenated vegetable shortening, 72 g. eggs, 770 g. sifted all-purpose flour, 120 ml. lukewarm water, and 2 packages (15 g.) active dried yeast. Flour, sugar, and salt were purchased in ample quantity to complete the series of experiments; milk and eggs were purchased prior to each baking. Two lots of shortening and yeast were obtained. Since the storage life of yeast is limited and its use beyond a certain date not recommended by the manufacturer, one lot was purchased in November 1950 for half of the bakings and a second lot in January 1951.

The straight dough method of mixing *(6)* was used. Doughs were mixed with a beater attachment and kneaded with a dough hook in a five-quart Model F Kitchen-Aid Mixer. All ingredients, except 5 cups of the flour, were mixed 15 seconds at low speed and 30 seconds at medium speed. The remainder of the flour was added. The doughs were kneaded at low speed 5 minutes, then transferred to a greased bowl and allowed to rise 75 minutes in a fermentation cabinet. The cabinet was maintained at a high relative humidity and at a temperature of 30° C. ± 0.5° throughout the study.

Following fermentation, doughs were punched down once and kneaded at low speed for 30 seconds. For each roll two 15-g. portions of dough were formed into balls and placed in a greased muffin tin. Shaped doughs for brown-and-serve rolls were proofed in the fermentation cabinet 45 minutes and baked 25 minutes at 135° C. Then the unbrowned rolls were cooled 20 minutes, removed from muffin pans, and placed on racks. For fresh standard brown-and-serve rolls, 4 from each batch were browned 9 minutes in an electric bread oven maintained at 204° C. Shaped doughs for regular baked rolls were proofed one hour and baked 15 minutes at 204° C. Baked rolls were cooled 5 minutes in muffin pans and then turned out on racks.

Two lots of shaped fermented rolls and 3 lots of brown-and-serve rolls and of baked rolls were frozen and fresh standard brown-and-serve and baked rolls were prepared on each of 12 baking days (Table 1).

TABLE 1
Schedule of preparation of dough and rolls, distribution of samples, and intervals of freezer storage

Dates of preparation	Intervals of freezer storage					
	Brown-and-serve rolls, baked rolls, and shaped dough				Brown-and-serve rolls and baked rolls	
	1 week	*3 weeks*	*6 weeks*	*9 weeks*	*12 weeks*	*15 weeks*
11-17-50	x			x		x
11-22-50			x	x		x
12-1-50			x	x		x
12-6-50	x		x			x
12-13-50		x		x	x	
12-20-50		x		x		x
1-25-51	x			x	x	
1-31-51	x	x			x	
2-6-51	x		x		x	
2-9-51		x	x		x	
2-22-51		x	x			x
3-6-51	x	x			x	

Preparation for freezing. In this study roll dough was frozen after fermentation and shaping because a limited amount of preliminary work showed that rolls prepared from frozen fermented shaped doughs were preferred to rolls made from either unfermented shaped or fermented unshaped frozen dough. The shaped fermented rolls in individual paper cups were packaged in one-pint aluminum boxes so that the dough could not spread out and the original shape would be retained. The boxes were immediately placed in a home freezing unit maintained at −23.5° C. ± 1°. Cooled brown-and-serve rolls were packaged for freezing in quart-size polyethylene bags and baked rolls in sheets of aluminum foil. These products were too large for the pint-size aluminum boxes which were available. The unbrowned brown-and-serve rolls were packaged in bags because

wrapping tightly in aluminum foil changed their shape, while the baked rolls were wrapped in aluminum foil so that they could be thawed and reheated in the oven in the original wrappings. The packages, each containing four rolls, were placed in the freezing unit. The following day the packages were put into cardboard boxes and transferred to a storage section of the freezer.

Treatment after freezer storage. Six replicate samples of dough, removed from the freezer after 1, 3, 6, and 9 weeks, were thawed and proofed in greased muffin pans for 2, 2.25, 2.5, and 2.5 hours, respectively, in the fermentation cabinet. The original plan was to proof to the same height as that attained by the fresh dough. This was accomplished with doughs frozen and stored one and 3 weeks. However, the doughs held in freezer storage for 6 and 9 weeks never reached the same height and, if proofing were extended beyond 2.5 hours, deterioration occurred. These rolls were baked 15 minutes at 204° C. and cooled 5 minutes in the pans.

Six replicate samples of frozen brown-and-serve and of frozen baked rolls were removed from freezer storage after 1, 3, 6, 9, 12, and 15 weeks. Brown-and-serve rolls were thawed 2.5 hours at room temperature in unopened bags, then placed in muffin tins, browned 9 minutes at 204° C., and cooled 5 minutes. Baked rolls were thawed and heated 20 minutes at 204° C. in aluminum foil packages.

Analytical methods. Yeast plate counts and determinations of gas production were made on freshly prepared doughs and on shaped, fermented doughs which had been frozen for 1, 3, 6, and 9 weeks. An improved pressuremeter as described by Sandstedt and Blish *(10)* was used for the manometric measurements of gas production, and the method employed was a modification of theirs. A 30-g. sample of dough was placed in the pressuremeter when the other fermented shaped rolls were proofed. The aluminum cup of the pressuremeter was kept at constant temperature in a water bath at 30° C. ± 0.5°, and 5 minutes were allowed for the system to come to this temperature before the manometer was set. Manometer readings on the fresh doughs were recorded after 1.0 and 2.0 hours with the pressure being released between the periods. With frozen doughs 0.5 hour was required for the internal temperatures to approximate 30° C., and gas was produced during this thawing period. Manometer readings were taken after 0.5 and 1.5 hours; then the pressure was released and a reading recorded after another hour. Gas production was measured in terms of gas pressure in millimeters of mercury and the comparison of gas production by fresh and frozen doughs was based on the amounts obtained in 2.0 and 2.5 hours, respectively.

For plate counts of viable yeast cells, 15-g. samples of dough were weighed out after proofing and blended with sterile water for four minutes in a Waring Blendor. Dilutions were made to give counts within the recommended range of 30 to 400 yeast cells per plate. One milliliter aliquots were plated in triplicate with nutrient agar. Counts were made after incubation of plates for 2 days in a constant temperature oven maintained at 30° C. ± 1°.

The rape seed displacement method recommended by Morgan and Hall *(8)* was used to measure volumes of freshly baked rolls and of frozen rolls after preparation for serving. All rolls were allowed to cool approximately one hour before the weight of seeds displaced by two rolls was determined; volume was then calculated in milliliters.

Four members of the food research staff rated the palatability of rolls on a modified yeast bread score sheet *(6)* five minutes after the rolls were removed from the oven. The following scale for judging shape, crust, volume, texture, grain, color, and flavor was used: 5, excellent; 4, good; 3, fair; 2, poor; and 1, very poor. When scores were 3 or lower, reasons were given by the judges. Factors were weighted and final scores recorded on the basis of a total maximum of 100 points.

RESULTS AND DISCUSSION

Mean values for the gas produced by 30-g. samples of fresh and frozen yeast doughs and for the mean percentages of original gas production by frozen doughs are given in Table 2. The lot of yeast used in preparing doughs was a factor which influenced the amount of gas produced in 2 or 2½ hours. Less gas was evolved in fresh doughs containing the first lot of yeast purchased than in doughs containing the second lot. Mean values for gas production were 451 mm. and 547 mm., respectively. However, with both lots of yeast less gas was produced by the doughs as the time in freezer storage lengthened. Values for the mean gas production of frozen doughs held in freezer storage for 1, 3, 6, and 9 weeks were 91, 80, 75, and 61%, respectively, of the mean values for fresh doughs for the same batches. Differences between mean gas production figures of fresh and frozen doughs were statistically significant after all storage periods except the first of one week.[b] These findings do not agree with those of Tilghman *(11)* who reported no consistent decrease in gas production of fermented and unfermented doughs due to freezer storage.

TABLE 2
Effect of freezing and freezer storage on gas production of dough

Number of determinations	Mean values for gas production of fresh dough in 2 hours	Periods of freezer storage	Mean values for gas production of frozen dough in 2.5 hours[a]	Mean percents of gas production (frozen/fresh) and standard deviations of the means
	mm. Hg.	*weeks*	*mm. Hg.*	%
6	516	1	466	91 ± 2.6
6	517	3	409	80 ± 1.0
6	494	6	366	75 ± 4.5
6	469	9	286	61 ± 2.3

[a] Mean values for gas production in the 0.5 hour thawing periods were 60, 53, 56, and 47 mm., respectively, after 1, 3, 6, and 9 weeks of freezer storage.

Plate counts of the numbers of viable yeast cells in replicate plates and samples varied to a wide extent. Mean numbers of viable yeast cells of doughs held in freezer storage for 1, 3, 6, and 9 weeks were 88, 80, 83, and 56 million per gram of dough, respectively. Corresponding lots of fresh doughs had mean counts of 85, 90, 92, and 94 million. Only after 9 weeks of freezer storage was there a significant difference between the numbers of viable yeast cells in fresh and frozen dough. Godkin and Cathcart *(4)* in a study of survival of yeast in roll doughs observed that frozen doughs retained normal yeast activity for one to 3 weeks. Yeast plate counts appeared to support the baking tests for part of the time, but as the storage interval lengthened counts became erratic.

The effect of freezing and freezer storage on volume of yeast rolls as determined by the rape seed displacement method is shown in Table 3. Rolls baked from frozen dough had significantly smaller volumes than freshly baked rolls after each interval of freezer storage. The mean volumes of rolls prepared from doughs held in freezer storage for 1, 3, 6, and 9 weeks were, respectively, 87, 86, 77, and 65% of the mean volumes of corresponding fresh rolls. The mean volumes of the frozen brown-and-serve rolls after preparation for serving ranged from 94 to 98% of the volumes of the freshly prepared brown-and-serve rolls, but none of the

[b] A difference was considered significant if it was 3 or more times as large as the standard error of that difference.

TABLE 3

Effect of freezing and freezer storage on the volume of rolls

Number of determinations	Mean volumes of two rolls ml.	Weeks of freezer storage	Mean volumes of two rolls ml.	Mean percents of volumes (frozen/fresh) and standard deviations of the means
Rolls baked from fresh and frozen dough				
	Freshly baked		Baked from frozen dough	
6	246	1	214	87 ± 1.3
6	236	3	203	86 ± 1.9
6	239	6	184	77 ± 2.5
6	234	9	152	65 ± 3.0
Brown-and-serve rolls				
	Freshly baked		Frozen, thawed, and browned	
6	204	1	201	98 ± 1.9
6	204	3	198	97 ± 1.3
6	204	6	195	95 ± 0.4
6	189	9	186	98 ± 1.2
6	207	12	201	97 ± 2.2
6	194	15	182	94 ± 1.0
Baked rolls				
	Freshly baked		Frozen and reheated	
6	246	1	232	94 ± 1.9
6	236	3	222	94 ± 1.9
6	239	6	219	92 ± 1.3
6	234	9	220	94 ± 1.3
6	245	12	232	95 ± 1.3
6	232	15	211	91 ± 2.3

differences were significant. The mean volumes of reheated frozen baked rolls measured between 91 and 95% of the original volumes. With exception of the frozen baked rolls held 6 and 15 weeks, differences between the mean volumes of frozen baked rolls and of corresponding freshly baked rolls were not statistically significant.

Mean ratings for 7 palatability factors and for the total scores of freshly baked and frozen rolls are presented in Table 4. The mean total score of 95 for all freshly baked rolls corresponded to a descriptive rating of between high good and excellent. Freshly baked rolls were scored significantly higher than rolls prepared from frozen doughs or frozen rolls. The quality of rolls baked from frozen shaped doughs progressively deteriorated as the periods of freezer storage were lengthened. Rolls prepared from doughs held in freezer storage for 3 weeks had slightly blistered crusts and were rather doughy in texture and yeasty in flavor. The surface of rolls baked from doughs frozen 6 and 9 weeks was blistered, mottled, and pale. Texture was described as doughy, tough, heavy, and compact, while grain was coarse with large holes present throughout. The mean flavor scores after 6 and 9 weeks of freezer storage were slightly below fair. Sunderlin, Collins, and Acheson *(13)* found undesirable flavors and odors, which they attributed to rancidity or to absorption of odors, in rolls baked from doughs which had been in freezer storage over 6 weeks. In this study no rancidity was detected, but some judges objected to the yeasty flavor and others to a flat taste.

Rolls prepared from doughs held in freezer storage for 6 and 9 weeks were flat on top and small in volume. After these intervals volume was rated high fair and poor, respectively. Marked decreases in volume ratings were correlated with smaller volumes by objective measurements, lower yeast plate counts and lower gas production. In published work on frozen doughs approximate maximum storage periods recommended are one week *(11)*, 4 weeks *(15, 16)*, and 6 weeks *(7, 9, 12, 13)*. Fenton *(2)* reported that some frozen unbaked rolls were good after 8 weeks of storage. With the formula and method used in the present investigation rolls baked from frozen shaped doughs were considered good after one week, high fair after 3 weeks, and unsatisfactory thereafter.

TABLE 4

Effect of freezing and freezer storage on palatability ratings of rolls

	Weeks of freezer storage	Number of ratings[a]	Mean ratings							
			Shape	Crust	Volume	Texture	Grain	Color	Flavor	Total scores and standard deviations of the means
Maximum scores			10	10	10	20	10	10	30	100
Rolls baked from fresh and frozen dough										
Freshly baked		48	10	9	10	18	10	10	29	95 ± 0.5
Baked from frozen dough	1	24	9	7	9	15	8	10	24	81 ± 1.2
	3	24	8	6	8	14	7	9	21	73 ± 1.5
	6	24	6	6	7	12	6	8	17	63 ± 1.5
	9	24	6	6	4	9	6	8	17	56 ± 1.0
Brown and serve rolls										
Freshly baked		48	8	9	9	15	9	10	26	86 ± 0.6
Frozen, thawed, and browned	1	24	8	8	8	14	8	10	24	81 ± 1.1
	3	24	8	8	8	13	8	10	21	75 ± 1.1
	6	24	8	8	8	14	8	10	22	77 ± 1.1
	9	24	8	8	7	12	8	9	21	73 ± 1.0
	12	24	8	7	8	13	8	9	20	72 ± 0.9
	15	24	7	7	7	12	7	9	18	67 ± 1.0
Baked rolls										
Freshly baked		48	10	9	10	18	10	10	29	95 ± 0.5
Frozen and reheated	1	24	10	9	10	17	9	10	27	91 ± 1.0
	3	24	9	8	10	16	9	10	25	86 ± 0.9
	6	24	9	8	10	16	9	10	24	85 ± 0.8
	9	24	9	8	10	16	8	10	24	85 ± 0.7
	12	24	9	8	9	15	8	9	24	82 ± 1.0
	15	24	8	8	9	16	8	10	24	83 ± 0.8

[a] Each sample was rated by four judges.

The mean total palatability score of freshly prepared brown-and-serve rolls was 86, a rating of between good and high good, and one which was significantly lower than the mean rating for regular freshly baked rolls. After one week of freezer storage brown-and-serve rolls were considered good although a slightly yeasty flavor was noted and the crusts were less crisp. As the time in storage increased the texture became more doughy, the grain slightly coarser, and the yeasty flavor more pronounced. However, after 6 and 9 weeks brown-and-serve rolls were significantly more palatable than rolls prepared from frozen doughs held 6 and 9 weeks. After 12 and 15 weeks the crusts of brown-and-serve rolls were uneven, cracked, and wrinkled in appearance.

Baked rolls were rated high good after one week of freezer storage. The crusts of reheated frozen baked rolls were crisper but were scored no lower for this characteristic than freshly baked rolls. After each storage period the mean total palatability scores of baked rolls were significantly higher than those of rolls prepared from frozen doughs or frozen brown-and-serve rolls, and after 15 weeks the mean rating of the frozen baked rolls was slightly above good. In addition, freezing baked rolls was desirable from the standpoint of convenience. Since they were heated in the oven immediately after removal from the freezer, a minimum of preparation time was required. Beattie, Edelmann, and Cathcart *(1)* reported that rolls baked before freezing and stored 9 months were satisfactory. Fenton *(2)* obtained baked rolls excellent in quality even after 12 months of freezer storage. In work supplementary to the present investigation baked rolls which had been in freezer storage for 6 months were considered good. However, the practicality of storing frozen rolls this long is questionable because of the freezer storage space that would be required.

SUMMARY

Effects of freezing and freezer storage on the quality of rolls prepared from frozen, shaped doughs held for periods of 1, 3, 6, and 9 weeks and on the quality of brown-and-serve and of baked rolls held in freezer storage 1, 3, 6, 9, 12, and 15 weeks were investigated.

There were statistically significant decreases in mean gas production values of frozen doughs after 3 weeks of freezer storage and less gas was produced by the doughs as the length of time in freezer storage increased. Plate counts of viable yeast cells in replicate samples of doughs varied to a wide extent, but after 3 weeks of freezer storage there was a decrease in the mean plate count and after 9 weeks the mean plate count was significantly lower than the fresh.

All rolls prepared from frozen doughs were significantly smaller in volume than freshly prepared rolls as measured by seed displacement, and after 9 weeks of freezer storage the mean volume was only 65% of the mean original volume. Mean volumes of brown-and-serve and of baked rolls were 94 and 91%, respectively, of the mean original volumes after 15 weeks of storage.

Judges rated the palatability of freshly baked rolls between high good and excellent. Rolls prepared from doughs held in freezer storage for one and 3 weeks scored good and high fair, respectively, while those stored 6 and 9 weeks were considered unacceptable. Rolls prepared from frozen brown-and-serve rolls were rated similarly to rolls baked from doughs frozen one and 3 weeks and higher than those held in freezer storage 6 and 9 weeks. Brown-and-serve rolls frozen 15 weeks were rated fair.

Frozen baked rolls rated between high good and good during 15 weeks of freezer storage. The baked rolls had a smooth brown crust, were well shaped, and had good volume. They were light and tender and the flavor was pleasing throughout the 15 weeks. Less time was required to prepare frozen baked rolls for serving than to prepare either frozen shaped dough or frozen brown-and-serve rolls for serving. On the basis of the results obtained and the observations made in this study, it is recommended that rolls be baked before freezing.

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Viability of Thermophilic Bacteria in the Presence of Varying Concentrations of Acids, Sodium Chloride and Sugars[a]

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(Manuscript received November 15, 1952)

A study was made of the influence of acids (acetic, citric and lactic), sodium chloride and sugars (dextrose, sucrose, fructose) on the viability of five representative cultures of thermophilic bacteria.

The order of effectiveness of the acids in terms of germicidal action was found to be citric > acetic > lactic. For the sugars the order was found to be dextrose > fructose > sucrose. Concentrations of sodium chloride above 1.5 per cent proved germicidal while concentrations below 1.0 per cent accelerated growth in some cases.

In all cases normal growth was observed to be very rapid, the maximum cell count being attained after about eight to sixteen hours. This exceptionally high growth rate was followed by a pronounced and rapid death rate, sterility of some cultures ensuing after 48-96 hours.

Important as thermophilic bacteria are in the food industry, especially in the spoilage of canned foods, the literature reveals only a paucity of information on their classification and physiological characteristics. Schmidt *(21)* significantly remarked "The group of organisms known as obligate thermophiles has been completely neglected."

Thermophilic spoilage has for years been a vexing problem to food canners, food technologists and food bacteriologists. The ubiquitous nature of the thermophilic bacteria and the extraordinarily high heat resistance of their spores greatly increase the probability of spoilage in industry. They may occur in food ingredients such as sugar and starch. The spoilage of sugar in storage and during shipment has been attributed to their action. Several cases of wholesale loss of inadequately processed canned foods due to thermophilic spoilage have been reported. Beans, peas, corn and non-acid foods in general, as well as tomatoes, are very susceptible. In all such cases the flat sour obligate thermophiles, in the sense of the definition of Cameron and Esty *(5)*, are of particular importance.

The retreat of the Allied armies in the North African campaign during World War II was ascribed by some to be due in part to a shortage of rations incurred as a result of thermophilic spoilage of canned foods stored in the warm African desert. Spoilage of canned foods due to the same cause occurred in the Pacific. With the current strategic importance of the Pacific theatre and with large shipments of edible materials pouring into these localities, thermophilic spoilage is again a problem of impressive stature. Further close study of the behavior of these organisms may therefore be profitable.

Acids, salt and sugar occurring either naturally or added in varying proportions play an important role in the vast modern enterprise of food preservation; their preservative action was recognized even by primitive man. The hydrogen-ion concentration of food influences its deterioration by microorganisms. Concentrated solutions of salt and sugars are used to preserve certain foods by repressing development of microorganisms; meat, pickles, cabbage, onions, peppers, cauliflower and other vegetables being preserved by salt and many fruits by sugar sirups.

The influence of acids, salt and sugars on thermophilic bacteria has not been extensively studied. As a result, opinions differ widely as to the kind and quantity of any of these ingredients to be used for effective but, at the same time, economical preservation. The general objective of these studies was to ascertain the trend of growth of thermophilic bacteria in a specific medium which had been adjusted to different pH levels with different acids or to which increasing concentrations of salt or sugar had been added. It was decided that the role which acid, salt and sugar play in the preservation of foods should be determined—specifically, (a) The order of effectiveness, bacteriostatically and bactericidally, of certain acids, salt and sugars against thermophilic bacteria. The acids were used to adjust the medium to the same pH level while the salt and sugars were added in increasing concentrations. (b) The minimum, or probable, time for which the medium so treated and inoculated with thermophilic cultures would have to be incubated in order to reduce the bacterial population. (c) The relative rates of death of thermophilic bacteria isolated from various sources when incubated for varying periods in a medium so treated.

LITERATURE REVIEW

A very lucid review of the literature on the nature of thermophiles is given by Gaughran *(3)*, but a brief resumé will be useful as background for the present study.

Thermophilic bacteria have been variously characterized. They may be simply defined as unicellular spore-forming microorganisms depending for their existence on animal or plant tissues and which grow at relatively high temperatures. Prickett *(17)* after sifting the various definitions accepted the one given by Cameron and Esty *(5)* who divided them into obligate and facultative thermophilic bacteria. Imsenecki and Solnzeva *(11)* have divided them, on a temperature basis, into stenothermal and eurithermal thermophiles, while Bergey *(4)* classifies them as true and facultative thermophiles.

Gaughran *(3)* pointed out that the multiple connotations of the terms used to describe thermophiles have led to much misinterpretation. He thinks that bacteria with any optimum growth temperature of between 50° C. and 60° C. may be called thermophiles and suggests that, if necessary, the terms of Imsenecki and Solnzeva *(11)* should be used for defining the magnitude of the temperature range for growth.

The effect of acids. Erickson and Fabian *(8)* showed that thermophiles are more susceptible to increasing concentrations of acids than mesophiles. Anderson and co-workers *(1)* demonstrated that lactic, acetic, and citric acids in increasing concen-

[a] Journal Article No. 1428.

trations reduced the thermal destruction rates of *Bacillus thermoacidurans*, the relative order of efficiency being lactic > citric > acetic. Pederson and Becker *(16)* concluded that there seems to be a significant difference between the minimum pH for the growth of vegetative cells and the minimum pH for the germination of spores of *B. thermoacidurans;* vegetative cells initiated growth in broth of pH as low as 4.38, while heat-resistant spores were incapable of germination at pH below 5.0. Nunheimer and Fabian *(15)* found that on a pH basis, the order of effectiveness for the germicidal action of the acids against strains of food poisoning staphylococci was acetic > citric > lactic > malic > tartaric > HCl. The order for growth-inhibiting properties was the same, except that citric and lactic acids changed places in the series. Levine and Fellers *(13)* noted that acetic acid was much more effective than either hydrochloric or lactic acid against *Saccharomyces cerevisiae* or *Salmonella aertrycke*. Wyeth *(26)* reported that on a pH basis the order of effectiveness against coliform bacteria was acetic > lactic > hydrochloric. Shillinglaw and Levine *(22)* found that in a concentration of 0.02N the order of effectiveness of the edible acids as germicides against *Escherichia coli* at 30° C. was tartaric > lactic > acetic > citric.

The influence of salt. The influence of salt on the viability and thermal resistance of microorganisms has commanded the interest of various investigators who have reported both increased lethality and a definite protective effect. Viljoen *(24)* found that concentrations of sodium chloride up to 3.5 percent in pea liquor gave a protective effect against heat to certain microorganisms including thermophiles. The greatest protection was observed at 1.0-2.5% while 4.0% either gave no protective action or else had a killing effect. Anderson *et al. (11)* showed that the addition of increasing amounts of salt to tomato juice resulted in a progressive increasing of the hydrogen ion concentration and a concomitant more rapid destruction rate for *B. thermoacidurans.*

The influence of sugars. Erickson and Fabian *(8)* demonstrated clearly that thermophiles are much less resistant to the effects of sugars than other microorganisms such as *Streptococcus lactis* and *Streptococcus liquefaciens.* They found, for three cultures of thermophiles, a preservative action in the presence of 17.5% fructose, 27.5% dextrose and 40 to 45% sucrose. Anderson *et al. (1)* found that increasing concentrations of sucrose and dextrose in tomato juice enhanced the thermal resistance of *B. thermoacidurans.* Robertson *(19)* observed an increasing protective action for several microorganisms, including *Streptococcus thermophilus,* when heated in increasing concentrations of sugars. Several workers including Baumgartner and Wallace *(3)* and Fay *(9)* found that the thermal resistance of some microorganisms when heated in hypertonic solutions of sucrose, glucose, lactose and other sugars is increased.

PROCEDURE

The cultures[5] of thermophilic bacteria used in this investigation were: Obligate thermophile flat sour No. 26, 1373 and 1503 isolated from corn, hominy and peas respectively, and facultative thermophiles No. 1401 and 1518 isolated from pumpkin and corn respectively. Culture No. 1373 became contaminated during the experiment and was omitted from the later experiments.

The food ingredients whose effect on the viability of the above thermophilic bacteria was studied and their sources are as follows: acids—acetic—Glacial, C.P. grade, citric—Baker's analysed, C.P. grade, lactic—Edible lactic acid, 50 percent; salt—C.P. sodium chloride, Merck; sugars—dextrose, Bacto dextrose, anhydrous, sucrose, C.P., fructose (levulose) C.P.

Growth curves were run on cultures 26 1401, 1503 and 1518 in order to determine their rate of growth and death in dextrose tryptone broth and the approximate time intervals at which platings were to be done throughout the experiment.

Methods. Fifty ml. portions of sterile dextrose tryptone broth were pre-heated to 55° C. to afford optimal temperature from the very start. Each was inoculated with 1 ml. of a suspension of each organism, washed from a 48-hour dextrose tryptone agar slope and incubated in a water bath maintained at 55 ± 1° C. Plate counts were made at 2 hour intervals up to 20 hours, and at 6 hour intervals up to 48 hours and also at 72 and 96 hours.

A sterility test was run on each batch of acid as follows: A drop of the acid was added to a test tube containing 10 ml. of dextrose tryptone broth. The tube was then incubated at 55° ± 1° C. for 48 hours. In no instance, however, did thermophiles appear in any of the acids used.

Using aseptic precautions throughout all manipulations, sterile dextrose tryptone broth was adjusted with the aid of a Beckman pH meter, to the required pH values. Fifteen ml. portions were then dispensed into sterile test tubes.

Sodium chloride, in concentrations of 0, 0.5, 5, 1.5, 2.5, 5.0, 10, 15, 20 and 25% by volume, was added to dextrose tryptone broth and the mixture heated in the steamer to dissolve all the ingredients. The broth was then dispensed in 15 ml. quantities into test tubes and the tubes autoclaved at 121° C. (250° F.) for 15 minutes.

In the case of dextrose, amounts equivalent to 5, 10, 20, 30, 40, and 50% by volume were added to tryptone broth and the procedure repeated exactly as in the case of the salt solutions. For fructose and sucrose 100% weight by volume solutions were made up and autoclaved at 10 pounds pressure for 10 minutes. Enough of these stock solutions were then aseptically pipetted into sterile flasks to make up 100 ml. of each of the concentrations required. From these flasks 15 ml. portions were then aseptically pipetted into sterile test tubes.

All cultures were grown on dextrose tryptone agar slants for 48 hours. This allowed the use of cultures of a standard age of 48 hours throughout the experiment.

All the tubes of broth for the acid, salt or sugar test were preheated at 55° C. for 2 hours. The 48-hour cells were washed off the dextrose tryptone agar slopes using 10 ml. of sterile distilled water. Into each of the tubes, 1 ml. of the well-shaken cell suspension was inoculated, kept in a water bath maintained at 55 ± 1° C. during this process, and tubes then incubated at 55 ± 1° C.) Plating on dextrose tryptone agar by the pour plate method was done from each tube after 0, 6, 12, 24, 48, and 96 hours of incubation and plates incubated at 55 ± 1° C. for 36 hours. All inoculations of tubes and platings from tubes were done in duplicate.

RESULTS AND DISCUSSION

Figure 1 shows the normal growth curves in dextrose tryptone broth for cultures 26, 1401, 1503, and 1518 after increasing periods of incubation. Figure 2 shows the logarithmic growth curves of 5 thermophiles when grown at 55° C. in dextrose tryptone broth adjusted to pH 5.5 with acetic, citric, and lactic acids respectively. Figure 3 shows the logarithmic growth curves of 5 thermophiles, viz., No.'s 26, 1373, 1401, 1503, and 1518, when grown at 55° C. in dextrose tryptone broth to which various amounts of sodium chloride had been added. Figure 4 shows the logarithmic growth curves of 4 thermophiles, viz., No.'s 26, 1401, 1503, and 1518, when grown at 55° C. in tryptone broth to which different percentages of dextrose, fructose and sucrose respectively had been added.

From Figure 1 it is seen that in all cases maximum growth was evidenced after 8 to 14 hours of incubation. This was followed by a very rapid decrease in viable numbers which, in several cases, were much lower after 96 hours of incubation than the initial inocula.

Gaughran *(7)*, Imsenecki and Solnzeva *(11)*, and Hansen *(10)* all noted that the growth of thermophilic bacteria begins almost immediately after inoculation of the culture medium, the initial stationary phase being either absent or too short to be detectable. Both growth and death rates were found to be much more rapid than among the mesophiles, i.e. the generation time is much shorter and the logarithmic growth phase during which

[5] Obtained from the National Canners Association.

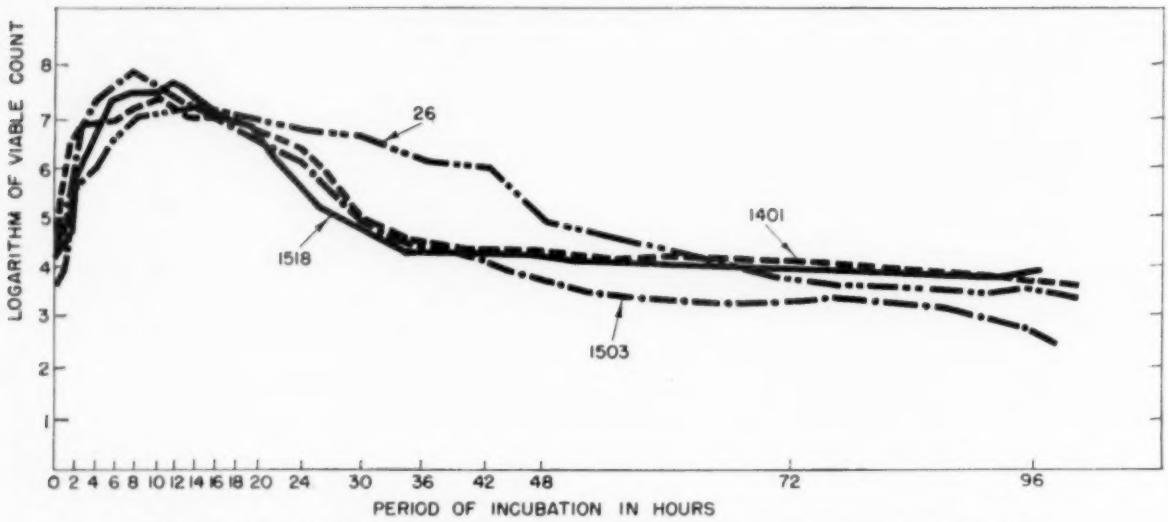

Figure 1. Normal logarithmic growth curves of test organisms in dextrose tryptose broth at 55° C.

the rate of multiplication remains constant was not evident in population curves. Imsenecki and Solnzeva *(11)* also noted that proteolysis, denitrification and hydrolysis of starch by thermophilic bacteria proceed at a rate seven to fourteen times that of cultures of mesophilic bacteria. Such rapid multiplication and death rates of cells have been attributed to: (a) The extremely high biochemical activity of thermophilic bacteria as a result of their rapid growth; (b) The inability of thermophilic bacteria to sporulate readily due to the very low oxygen tension in the liquid medium at such an elevated temperature *(7)*; (c) The rapid formation and accumulation of acids through the decomposition of carbon compounds in the medium if such are not neutralized, since the fermentation capacity of thermophiles has been calculated to be perhaps thirty times as great as that of *Streptococcus lactis* at 20° C.; (d) Cytolysis induced by autolysis with the resultant accumulation of toxic products in the medium. Evidence of autolysis has been obtained by way of the detection of an accumulation of enzymes in media inoculated with thermophiles *(11)*.

The effect of increasing concentrations of acids, salts, and sugars was determined in terms of percent increase or decrease of cell numbers relative to the initial inoculum. Results are recorded in Figures 2, 3, and 4. From Figure 2 it may be noted that at pH 5.5 the influence of the acids on growth follow the order citric > acetic > lactic.

In results not shown here when the acidity was increased by citric acid beyond pH 6.0 down to pH 5.5 there was decreased growth. Beyond pH 5.5, however, an increase in acidity resulted in no significant decrease in the number of viable cells. For acetic and lactic acids, multiplication occurred at pH 5.5 and germicidal action started at pH 5.0. A decrease in pH below pH 5.0 afforded no significant decrease in viable cells.

Several investigators have attributed the effect of added acids in suppressing the growth of bacteria to the change in the hydrogen ion concentration. However, Erickson and Fabian *(8)*, Anderson *et al. (1)*, Nunheimer and Fabian *(15)*, and Levine and Fellers *(13)*, have pointed out that the toxicity of certain organic acids is due in part to the undissociated molecule and the anion, in addition to the effect of the hydrogen ion.

Cohen and Clark *(6)* suggested that the action of acetic acid may be due to the free acetate radical exerting a synergistic effect upon the disinfecting power of the hydrogen ion.

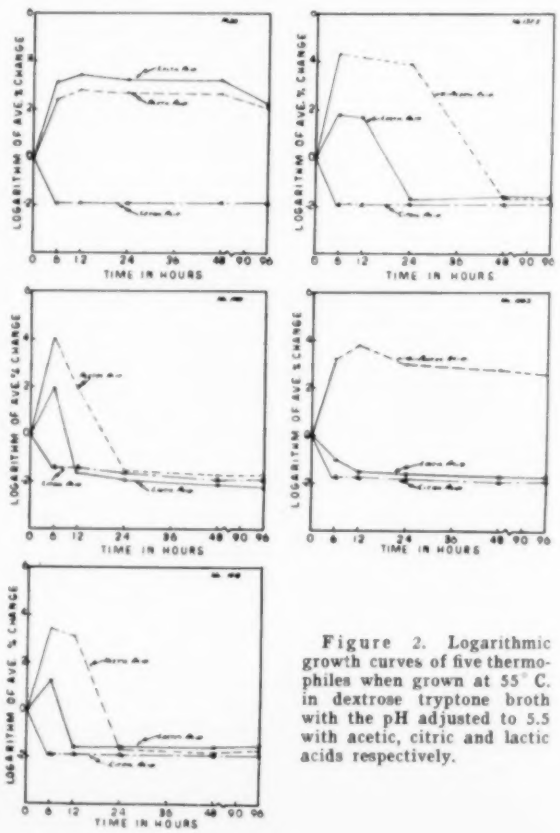

Figure 2. Logarithmic growth curves of five thermophiles when grown at 55° C. in dextrose tryptone broth with the pH adjusted to 5.5 with acetic, citric and lactic acids respectively.

Reid *(18)* believes that the anion and undissociated molecule may act independently in exerting their disinfectant action, or as positive catalysers increasing the bactericidal power of the hydrogen ions.

The influence of acids on the surface tension of the medium and the size of the molecule have been mentioned by Bach *(2)* as possible reasons for observed germicidal action. He also stated that the hydrogen ions control the antiseptic effect but the undissociated part of lactic acid is the germicidal factor when the pH value is important.

Traube's rule *(14)* states that in an homologous series of fatty acids the lowering of surface tension is parallel to the increase in molecular weight of the fatty acid. This may explain why citric acid is more germicidal than either acetic or lactic since of the three acids citric has the largest molecular weight. The dissociation of the acids may also account for the order of germicidal action observed.

If dissociation was the prime factor in the germicidal action then the order should be citric > lactic > acetic. This again may explain why citric acid was more toxic than either acetic or lactic acid. Since acetic acid was found to be more germicidal than lactic acid the undissociated molecule may be toxic as suggested previously.

From Figure 3 it may be seen that up to 1.5%, sodium chloride was non-germicidal except in the case of organism No. 1503. For No. 1503 germicidal action took place at 1.5% but not at 0.5%. Concentrations of 2.5% or greater proved germicidal in all cases. With culture No. 26 total destruction took place at 5.0% and greater.

The reason for the action of salt in inhibiting the growth of bacteria or destroying the cells is not readily apparent. Anderson *et al. (1)* observed that there is obviously no toxic entity in salt. Moreover, as prementioned, certain investigators including Viljoen *(21)* have attributed a protective effect from heat on some microorganisms by certain concentrations of salt. Anderson and his colleagues think that, inasmuch as the addition of increasing amounts of salt to media is known to result in increased hydrogen ion concentrations, the lethal effect of salt may be due at least in part to the lowered pH of the substrate.

The effect of salt on bacteria is thought by many investigators to be mainly and simply plasmolytic. Plasmolysis, however, is believed to last for only a few hours and not all bacterial cells are affected.

Rockwell and Ebertz *(20)* suggested that at least five factors are involved in the detrimental action of salt on bacteria, namely: (a) The direct effect of the chloride ion; (b) Dehydration; (c) The removal of oxygen; (d)) Sensitization against carbon dioxide; (e) Interference with the rapid action of proteolytic enzymes.

In addition to the above postulates it may be that, due to the dissociation of sodium chloride in solution, the sodium and chloride ions, though necessary for the growth of some organisms, and acceleratory in small amounts, become toxic in large quantities, i.e., as the concentration of salt is increased. This is an established fact in bacterial physiology. The law of diminishing returns seems evident as the concentration of salt gets

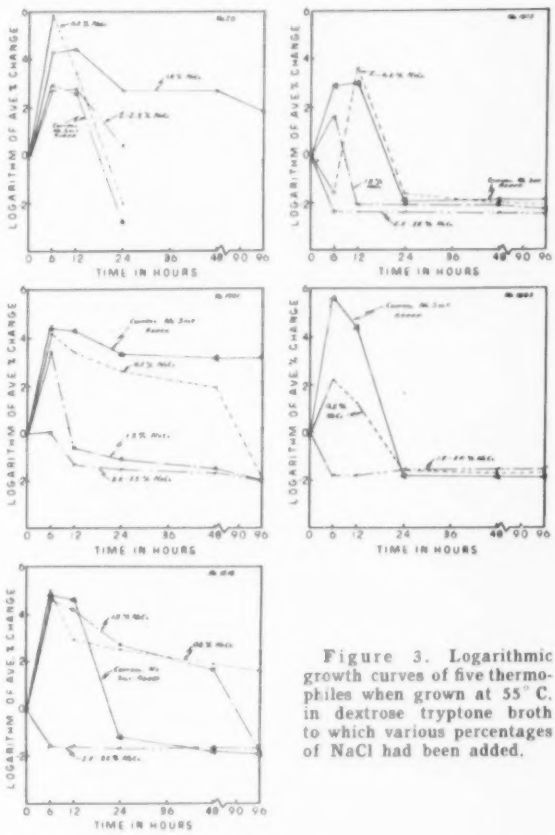

Figure 3. Logarithmic growth curves of five thermophiles when grown at 55° C. in dextrose tryptone broth to which various percentages of NaCl had been added.

beyond 2.5% since even a concentration of 2.5% gave no significant increase in germicidal action.

From the average percentages of increase or decrease over the initial inocula in the presence of varying concentrations of dextrose, fructose and sucrose shown in Figure 4, it may be seen that 5.0% dextrose did not suppress growth over the first 6-12 hours of incubation in the case of cultures 26, 1373, and 1518. A decrease of 66% occurred after 12 hours in culture 1503. For culture 1401 a decrease of 72% took place after 6 hours. A 10% solution of dextrose showed germicidal action for all organisms after 6 hours.

During incubation periods of 6-12 hours multiplication took place in the presence of 10.0% fructose. Concentrations of 20% or greater proved germicidal in all cases.

Except for organism 1401 sucrose in equivalent concentrations gave results in the same trend as fructose. Sucrose, however, was less destructive beyond 20.0%. The reverse of this holds true for organism 1401.

For all three sugars, increasing the concentration beyond that needed for germicidal action showed no increased lethality. The effectiveness of the sugars in reducing the bacterial count may therefore be written as dextrose > fructose > sucrose.

The reasons for the germicidal action of sugars against microorganisms are not well established. Concentrations of 10-50% of sucrose and dextrose are known to cause no appreciable change in the pH of cul-

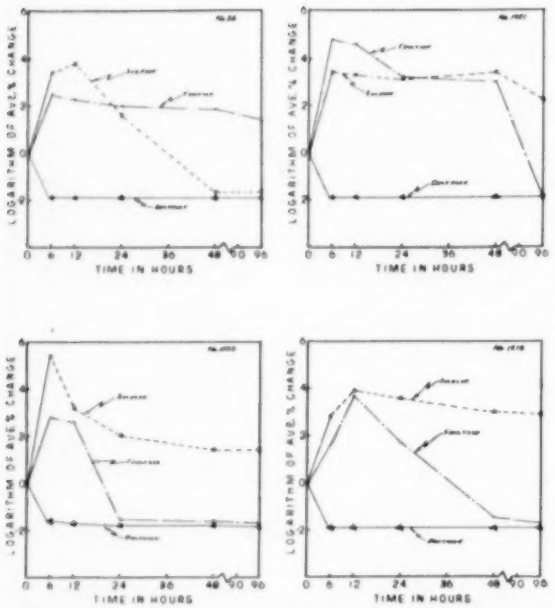

Figure 4. Logarithmic growth curves of five thermophiles when grown at 55° C. in tryptone broth to which different percentages of dextrose, fructose and sucrose, respectively, had been added.

ture media, hence no significant portion of the germicidal action of the sugars can be attributed to pH changes.

Fay *(9)* thinks that in both the protective and germicidal actions the influence of sugars on osmotic pressure determines their effectiveness. In his opinion the permeability of the individual cell apparently plays an important part in regulating the rate of death in water and in sugar suspensions. He hypothesises that resistance to the effects of sugars is limited to those cells which are highly sensitive to water at slightly increased temperatures.

Plasmolysis of the microbial cell may explain why dextrose exerted a germicidal effect at a lower concentration than either fructose or sucrose and why fructose exerted a greater germicidal action at the same concentration as sucrose. Osmotic pressure and hence plasmolysis depends on the number of particles in solution. Dextrose and fructose each with a molecular weight of 180 would, therefore, contain more molecules per unit of weight than would sucrose. The activity should, therefore, tend to decrease as the molecular weight increases. On a chemical basis, dextrose, an aldehyde sugar, should be less reactive than fructose, a keto sugar, as evidenced by the fact that many chemical tests can be carried out on the latter in the cold while the former must be heated. This order of activity apparently does not hold biologically in these experiments since dextrose was found to be more germicidal than fructose. The reason for this is not apparent. Furthermore, the results obtained here are contrary to those obtained by Erickson and Fabian *(10)* who found that the order of effectiveness was fructose > dextrose > sucrose > lactose.

SUMMARY AND CONCLUSIONS

The growth of thermophilic bacteria was found to be very rapid reaching a maximum within 8-14 hours, followed by a rapid decline in cell numbers. The lag phase of the growth cycle is not very pronounced and after 96 hours there were fewer viable cells present than in the initial inocula.

The order of germicidal action of the acids studied is citric > acetic > lactic. An increase in acidity beyond pH 5.0 gave no increased germicidal action.

Concentrations of sodium chloride up to 1.5% were not germicidal except for organism No. 1401 which was affected at this concentration. Concentrations of 2.5% and greater were germicidal in all cases. An increase in salt concentration beyond 2.5% gave no added germicidal effect.

The order of effectiveness of the sugars as germicides was found to be dextrose > fructose > sucrose. In all cases concentrations beyond 20.0% gave no significant increase in germicidal action.

From the growth curves it may be concluded that the deleterious action of various food ingredients on thermophilic bacteria occurs during the first 6 to 12 hours of incubation. This interval corresponds roughly to the phase of physiological growth and the early logarithmic phase of the bacterial growth curve.

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Effects of a Meat Tenderizer on Less Tender Cuts of Beef Cooked by Four Methods[a,b]

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(Manuscript received November 29, 1952)

Data are presented to show the effects of a commercial tenderizer on the palatability of less tender steaks and roasts of beef.

The tenderizer used was effective in increasing the tenderness of all steaks and of roasts treated at room temperature. Increase in tenderness as measured by judges' scores and shear values was highly significant for top round and sirloin tip steaks and for the bottom round steaks as measured by shear values.

Commercial meat tenderizers that contain the proteolytic enzyme, papain, are now on the market for consumer use. Few reports were found in the literature regarding the effectiveness of these tenderizers. According to Gottschall and Kies *(1)*, up to 1942 the greatest use of papain as a meat tenderizer had been empirical. The digestion of whole beef muscle and the survival of papain heated with beef muscle had not been studied quantitatively. Tauber *(4)* stated that the hydrolysis of meat by tissue-bound enzymes is a desirable process and is greatly accelerated by treating meat with various enzyme preparations. Commercial tenderizers now available usually are spread on the surface of the meat a few minutes before the meat is cooked, but the best results are obtained when the enzyme is allowed to penetrate into the meat by applying in deep cuts. Lowe *(2)* observed that if enzyme preparations are to give satisfactory results in tenderizing meat, they should be injected uniformly throughout all tissues. She found that papain applied to the surface of the meat in the form of dried, powdered, or bruised fresh papain leaves, or as a liquid, required time for the enzyme to act and then only a thin surface layer of the meat was affected.

Tenderness in meat treated with papain is induced by the enzyme as a result of protein breakdown. Although the exact relationship between the tenderizing effect and the protein digestion is not known, the more the meat is digested, the softer is the structure of the meat *(1)*. The purpose of this study was to determine the effects of a commercial meat tenderizer on the tenderness as well as on the flavor and juiciness of thick and thin round steaks, sirloin tip steaks, and rump roasts.

PROCEDURE

Untrimmed paired rounds from 3 carcasses, graded U. S. Commercial, were purchased from a Kansas City packing house. Steaks and roasts were cut from each of the 6 rounds as follows:

Top round	4	1.5-inch steaks
Bottom round	2	2.0-inch steaks
Bottom round	4	0.5-inch steaks
Sirloin tip	4	1.0-inch steaks
Rump	3	3.0-inch roasts

The steaks and roasts from the left and right sides of the carcasses were cut as pairs. Each cut of meat was wrapped in cellophane with an outer wrap of waxed locker paper, frozen in a blast freezer at −10° F. (−23.3° C.), and stored at 0° F. (−17.8° C.) until it was used.

Applying the tenderizer. A seasoned tenderizer was used on the sirloin tip steaks and an unseasoned tenderizer on the top and bottom round steaks and rump roasts. The steaks were randomized so that one steak from each pair was untreated (T_1). The other steak was treated with a commercially prepared meat tenderizer containing papain and allowed to stand at room temperature for one hour for each inch of thickness (T_2). A Latin square design was used for applying the treatments to the rump roasts. One-third of the roasts were untreated (T_1); one-third were treated with the tenderizer and allowed to stand at room temperature for one hour for each inch of thickness (T_2); and one-third were treated with the tenderizer and allowed to remain in the refrigerator at approximately 35° F. (1.7° C.) for 18 hours (T_3).

[a] Contribution No. 170 Department of Home Economics, Kansas Agricultural Experiment Station.

[b] Part of a thesis submitted to the graduate faculty by Pattie P. Hay in partial fulfillment of the requirements for the degree Master of Science.

Six grams of tenderizer per pound of meat was used for all treated cuts. A salt shaker was used to sprinkle a weighed amount of tenderizer on *2* sides of the steaks and over the entire surface of the rump roasts. Before and after applying the tenderizer the treated meat was "forked," i.e. the *2* surfaces of the steak were stuck with a fork from one side through to the other side and from all surfaces to the center of the roast.

Cooking methods. The methods of cooking used for the various cuts were: (a) broiling, top round steaks; (b) braising, two-inch bottom round steaks; (c) pan-frying, one-half-inch bottom round steaks and one-inch sirloin tip steaks; and (d) roasting, rolled rump roasts.

The steaks that were broiled were placed on a wire rack 8 inches in height set in a shallow pan in a rotary gas oven maintained at 400° F. (204.4° C.). The steaks were cooked to an internal temperature of 150° F. (65.6° C.). It was not necessary to turn the steaks because the heat reached them uniformly from all sides.

The braised steaks were slowly browned for 7½ minutes on each side in *20* g. of suet, then placed on a rack in covered enamel roasters with *30* g. of water. The steaks were placed in a rotary gas oven heated to 300° F. (148.9° C.) and cooked to an internal temperature of 176° F. (80° C.).

The one-half inch bottom round steaks and the sirloin tip steaks were pan-fried in *20* g. of suet *for 3* minutes on each side for each one-half inch of thickness. The skillet was heated to 400° F. (204.4° C.) and the gas flame was adjusted to maintain a temperature between *375*° F. (180.6° C.) and *425*° F. (*218.3*° C.) while the meat was frying.

The roasts were placed on a wire rack one inch in height set in a shallow pan. They were roasted in a 300° F. (148.9° C.) rotary gas oven to an internal temperature of 150° F. (65.6° C.). Two pair of broiled, braised or one-inch pan-fried steaks, *3* pair of one-half-inch pan fried steaks, or *3* roasts were cooked at one time.

Palatability tests. A panel of 8 judges scored the meat for aroma, flavor of the lean, tenderness, and juiciness. Scores for each factor were given within the range of 10 to one. Each judge also rated the samples according to his first, second, third, etc. choice, depending on the number of samples being tasted. Tenderness scores were given on the basis of the number of chews it took to completely masticate a bite of meat of a certain size. In addition to the tests by the palatability committee a test was made to determine if a group of 100 people had a preference for meat treated with the seasoned and unseasoned tenderizers or for untreated meat.

Objective tests. Cooking time, thawing losses, and total losses were determined for all cuts of meat. Volatile and dripping losses were determined for the broiled steaks and rump roasts. Shear values and press fluid yields for the broiled, braised, and one-inch pan fried steaks and for the rump roasts were measured by the Warner-Bratzler shearing apparatus and the Carver laboratory press. One-inch cores of meat were used for the shearing tests and *25*-gram samples of ground meat were used for press fluid determinations. The depth of penetration, in millimeters, into the one-half-inch pan fried steaks was measured by the Universal "Precision" penetrometer. The change in the shape of the steaks was studied by carefully measuring, in centimeters, the length, width, and thickness of each steak before and after cooking.

RESULTS AND DISCUSSION

Thaw Losses

The average thaw losses for the different cuts of meat from 3 carcasses varied from 0.7% for the rump roasts to 3.3% for the sirloin tip steaks. However, the average thaw losses for the top round steaks, the *2*-inch bottom round steaks, and the ½-inch bottom round steaks varied only 0.4%. The thaw losses for the top and bottom round steaks, sirloin tip steaks and rump roasts varied 0.1, 0.6, and 1.0%, respectively, between the left and right sides of the carcasses.

Cooking Time and Cooking Losses

Cooking time. The average cooking time per pound of meat for each cut and treatment is given in Table 1. The cooking time per pound of the broiled and braised steaks and the roasts treated with the tenderizer was less than for the untreated steaks or roasts. Broiled top round steaks treated with tenderizer required only 1.3 minutes per pound less than the untreated steaks. However, there was a greater difference between the average cooking times for the treated and untreated rump roasts and braised bottom round steaks. The cooking time for treated rump roasts averaged *7* minutes per pound less and that for the braised bottom round steaks 5.8 minutes per pound less than the untreated roasts or steaks. The cooking time per pound was not calculated for the pan-fried bottom round and sirloin tip steaks, as these steaks were cooked a certain length of time based on the thickness of the steak. The treated pan-fried steaks appeared to be more well-done than the untreated steaks when cooked for the same length of time. When cooked to the same internal temperature the treated broiled, braised, and roasted cuts appeared well-done, whereas the untreated cuts appeared medium-done. The breakdown of the muscle of meat that was "forked" and treated with the tenderizer probably allowed for a faster rate of heat penetration and may account for the shorter cooking time.

It is interesting that there was not any difference in the cooking time required for the roasts where the tenderizer was on the meat for 3 hours at room temperature and for those where the tenderizer was on the roasts for 18 hours at refrigerator temperature before cooking. The internal temperature of the roasts at the time they were placed in the oven was lower for those treated at refrigerator temperature than for those treated at room temperature and the untreated roasts.

TABLE 1
Average cooking time and cooking losses.

Cut and method of cooking	Cooking time min./lb.			Cooking losses in percent								
				Total			Volatile			Dripping		
	T_1		T_2	T_1		T_2	T_1		T_2	T_1		T_2
Top round steaks—broiled	27.6		26.3	24.8		23.0	20.8		18.3	3.4		4.3
Bottom round steaks—braised	28.3		22.5	30.4		33.4	—		—	—		—
Bottom round steaks—pan fried	—		—	19.0		17.7	—		—	—		—
Sirloin tip steaks—pan fried	—		—	15.9		16.5	—		—	—		—
Rump roasts—roasted	T_1	T_2	T_3	T_1	T_2	T_3	T_1	T_2	T_3	T_1	T_2	T_3
	52.3	44.8	44.9	21.1	22.8	21.7	16.6	15.7	14.5	4.3	6.8	7.2

T_1 Untreated.
T_2 Treated at room temperature.
T_3 Treated at refrigerator temperature.

Cooking losses. Average percentage cooking losses, as shown in Table 1, were less for the treated than for the untreated broiled round steaks and pan-fried round steaks. The lower cooking losses for the treated broiled round steaks were in agreement with the slightly shorter cooking time for these steaks. However, the treated and untreated pan-fried steaks were cooked the same length of time. In contrast, the untreated braised round steaks, pan-fried sirloin tip steaks, and rump roasts lost less weight during cooking than the treated cuts. All of the differences in cooking losses between the treated and untreated cuts were small and non-significant (5% level) when analyzed statistically.

Change in Shape

The length, width, and thickness of each steak were measured before and after cooking. There was a great deal of variation among the 84 steaks in the percentage changes which took place in each dimension during cooking. Approximately three-fourths of the steaks shrank in length and thickness and half of the steaks decreased in width. About one-fourth of the steaks gained in length, one-eighth of them became thicker, and a little more than one-third of them increased in width. A few of the steaks did not change in thickness and others did not change in width.

There was no consistent pattern in the change in the shape of the steaks that were treated with the tenderizer or of those that were not treated. However, all of the braised steaks decreased in length and thickness and two-thirds of them decreased in width during cooking. There was considerable variation in the way in which the steaks cooked by broiling or pan-frying changed in shape. The braised steaks were cooked well-done, whereas the other steaks were cooked medium-done. Apparently, when meat is cooked well-done, there is a tendency for it to shrink in all dimensions.

Winegarden *et al. (5)* reported that there was little change in beef connective tissues heated to 65° C. (149° F.) for short periods. But with continued heating at 65° C. (149° F.) and for short periods at higher temperatures the connective tissues softened, lost weight, decreased in length and width, and increased in thickness. These workers *(5)* stated that if connective tissues in muscle are similar to those used in their study, the cooking of roasts and steaks to rare and medium-done (55° to 65° C. or 131° to 149° F.) brings about little if any change in the connective tissues of muscle. Nevertheless, the changes in the length, width, and thickness of meat during cooking were thought to be affected, at least in part, by the collagen content of the muscle.

Palatability

Aroma and flavor. Average aroma and flavor scores for the steaks and roasts are given in Table 2. There was little difference in either the aroma or flavor scores for the treated and untreated meat. Analysis of variance of the flavor scores for each cut of meat showed no significant difference due to treatment. The sirloin tip steaks were treated with a seasoned tenderizer. During the first few tasting periods at least half of the judges preferred the flavor of the untreated steaks to that of the steaks treated with the seasoned tenderizer, but by the last of the tasting periods for these steaks more of the judges preferred the steaks treated with the seasoned tenderizer than the untreated steaks. The most frequent comment made by the judges regarding the seasoned tenderizer concerned the pronounced garlic flavor. Some of the judges liked this flavor and some did not; no doubt this was a deciding factor in determining the average flavor scores for the treated and untreated sirloin tip steaks.

Each judge rated the samples presented at each tasting period according to his first, second, third, etc. choice depending on the number of samples tasted. Both the average flavor scores and the ratings indicated preference for the treated steaks and for the untreated roasts. In a number of cases the judges commented that the flavor of the treated roasts was too strong and the texture was "mushy" or "mealy." Evidently the "forking" process was not sufficient for even distribution of the tenderizer throughout the roast. The surface area per unit weight of the roasts was much less than for the other cuts, thus the concentration of tenderizer in contact with the surface of the meat was greater. Also the tenderizer remained on the meat for a considerably longer time than for the other cuts of meat.

Tenderness. With the exception of the roasts treated at refrigerator temperature the treated meat was more tender than the untreated meat (Table 2). In addition to the action of the tenderizer, the procedure of "forking" the treated meat may have affected, to some extent, the tenderness. The degree to which the "forking" was

TABLE 2

Average palatability scores, shear values, press fluid yields, and penetrometer readings (highest possible score, 10)

Cut and method of cooking	Factor	Treatment		
		T_1		T_2
Top round steaks—broiled	Aroma	7.3		7.4
	Flavor	7.9		8.1
	Tenderness	7.1		8.4**
	Shear, lbs.	25.9		18.1**
	Juiciness	7.5		7.0
	Press fluid, ml.	8.9		9.0
Bottom round steaks—braised	Aroma	7.6		7.8
	Flavor	7.0		7.3
	Tenderness	6.2		7.4
	Shear, lbs.	26.9		17.9**
	Juiciness	5.1		5.1
	Press fluid, ml.	7.8		7.1
Bottom round steaks—pan-fried	Aroma	7.4		7.1
	Flavor	7.5		8.2
	Tenderness	7.1		8.2
	Penetrometer, mm.	6.7		7.1
	Juiciness	7.5		7.2
Sirloin tip steaks—pan-fried	Aroma	8.2		7.9
	Flavor	7.9		8.1
	Tenderness	7.2		8.4**
	Shear, lbs.	27.9		20.6*
	Juiciness	8.6		7.8
	Press fluid, ml.	9.4		8.8
		T_1	T_2	T_3
Rump roasts—roasted	Aroma	7.8	7.8	7.7
	Flavor	7.9	7.7	7.6
	Tenderness	7.7	7.8	7.5
	Shear, lbs.	18.3	13.9	19.3
	Juiciness	7.6	6.7	7.1
	Press fluid, ml.	8.0	7.8	8.5

T_1 Untreated.
T_2 Treated at room temperature.
T_3 Treated at refrigerator temperature.
*Statistically significant (5% level).
**Statistically highly significant (1% level).

effective in increasing tenderness is not known because there was no sample which was forked, and not treated with tenderizer. Differences of 1.2 and 1.3 points between the average scores for the treated and untreated pan-fried sirloin tip steaks and broiled top round steaks were highly significant (1% level). However, differences of 1.1 and 1.2 points between treated and untreated pan-fried and braised bottom round steaks were not statistically significant. There was a highly significant difference (1% level) in the shear values of the treated and untreated broiled top round and braised bottom round steaks and a significant difference (5% level) in the shear values of the treated and untreated pan-fried sirloin tip steaks. The difference in the average penetrometer readings (Table 2) between treated and untreated pan-fried bottom round steaks was not significant.

The tenderness scores and shear force readings for the roasts agreed in that the roasts treated at room temperature were the most tender and those treated at refrigerator temperature were the least tender. The differences among the tenderness scores and shear values for the three groups of roasts were not significant. A possible explanation of the difference in the tenderness of the roasts treated with tenderizer might be that more of the papain in the tenderizer was activated in three hours at room temperature than in 18 hours at refrigerator temperature. Gottschall *(1)* reported that more papain was activated in one hour at 70° C. (158° F.) than in 24 hours at 23° C. (73.4° F.); there might be a similar difference between the activity of papain at room temperature and refrigerator temperature. No explanation can be given for the untreated roasts being more tender than those treated at refrigerator temperature.

Juiciness. Average juiciness scores and press fluid yields, as shown in Table 2, were higher for the untreated cuts than for the treated cuts except for the braised steaks which were scored the same for both treatments. The differences in the average scores for the treated and untreated cuts were less than one point. However, the difference between treated and untreated broiled top round steaks (0.5 point) and treated and untreated pan-fried sirloin tip steaks (0.8 point) were highly significant and the differences in juiciness scores for the 3 groups of rump roasts were significant. Differences in press fluid yields of all the treated and untreated cuts were not significant. The treated meat may have seemed less juicy because it appeared to be more well-done than the untreated meat. The color of the juice from the treated cuts was a dull dark red, whereas that from the untreated samples was a bright red. The dark red color was more pronounced in the juice from the roasts than from the steaks. McCarthy and King *(3)* found a rapid rise in the hematin type pigment in the press fluid from samples of meat tenderized by the Tenderay process.

Preference Test

A group of 100 people tasted samples of untreated broiled sirloin tip steaks and broiled sirloin tip steaks that had been treated with the seasoned and the unseasoned tenderizer. Ninety-three percent of the group stated a preference for the meat treated with the tenderizer; 40% chose the steak treated with the seasoned tenderizer and 53% that treated with the unseasoned tenderizer. Flavor seemed to be the greatest factor in determining the preference for the unseasoned to the seasoned samples, and tenderness was the deciding factor for the preference of the treated to the untreated steaks.

SUMMARY

The effects of a commercial meat tenderizer on the palatability of thick and thin round steaks, sirloin tip steaks, and rump roasts cooked by 4 methods were studied. Untreated steaks were compared to those treated with the tenderizer at room temperature for one hour for each inch of thickness. Untreated rump roasts were compared with roasts treated with the tenderizer for one hour for each inch of thickness and with those treated at refrigerator temperature for 18 hours. A seasoned tenderizer was used on the sirloin tip steaks, whereas an unseasoned tenderizer was used on all other cuts.

Analysis of variance showed no significant differences due to the action of the tenderizer in the total cooking losses, aroma, or flavor of any of the cuts of meat. The tenderizer used was effective in increasing the tenderness of all the steaks and of the roasts treated at room temperature. The increase in tenderness, as measured by judges scores and shear values, was highly significant for the top round and sirloin tip steaks and for the bottom round steaks when measured by shear values. The differences among the tenderness scores and shear values for the 3 groups of roasts were not significant. Juiciness scores were higher for untreated than for treated meat. The differences in scores were highly significant for top round and sirloin tip steaks and significant for rump roasts. The press fluid yields for treated and untreated cuts were not significantly different, indicating that the color or the apparent degree of doneness of the meat may have had some influence on the juiciness scores.

Acknowledgment

Appreciation is expressed to Adolph's Food Products, Los Angeles, California for contributing to the financial support of this work, to Professor D. L. Mackintosh of the Department of Animal Husbandry at Kansas State College for procuring and cutting the meat, and to Dr. H. C. Fryer, Experiment Station Statistician, for suggestions on the design of the experiment.

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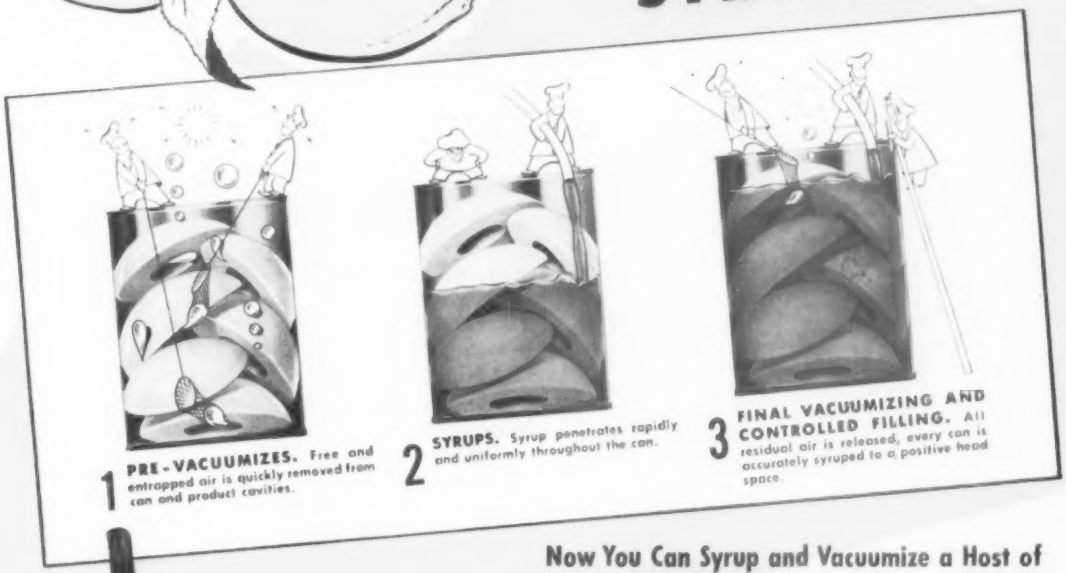
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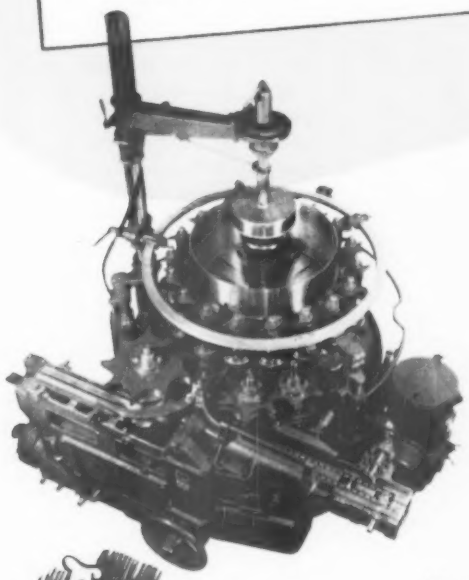

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Food Industry Topics

(Continued from page 18 preceding technical papers)

or frozen eggs could be used. Further information on Glucatase may be obtained from the Technical Service Dept., Chas. Pfizer & Co., Inc., 630 Flushing Ave., Brooklyn 6, N. Y.

◆ ◆ ◆

Two interesting news items from International Minerals and Chemical Corporation, Chicago. The first announces the election of Mr. Arthur R. Cahill as assistant treasurer of the company. He will be on the staff of Mr. Robert Resch, vice president and treasurer. During the past four years, Mr. Cahill has been vice president and treasurer of Montgomery Ward & Company. The second item concerns an *employee education plan* adopted by the company. All regular employees who have one year or more of continuous service are eligible to apply for assistance in paying for collegiate, professional, or semi-professional education relating to the fundamentals of their work. Under the plan, according to Mr. Louis Ware, president, the company will pay half the employee's tuition, registration, and laboratory fees for such courses in accredited institutions. Individuals taking graduate or advanced college level courses will also be allowed time off to attend classes up to six hours a week without loss of pay.

◆ ◆ ◆

A "good housekeeping" note might be of interest here. Word from Handling Devices Co., Inc., Brookline, Massachusetts, is that motorless Plantman Sweepers are now available with left and right hand side brush attachments. The attachments allow the 20" Plantman to provide a 32" sweeping path and a speed of 20,000 square feet per hour. The small Plantman thus equipped will sweep nearly as fast as power-driven units costing considerably more and according to the company there is no noticeable increase in pushing effort. For further information send for illustrated brochure to Room 91, Handling Devices Co., Inc., 43-45 Pearl St., Brookline 46, Mass.

● Easy does it—and quickly—on your plant or laboratory floors.

◆ ◆ ◆

A new and novel process for making a better cup of instant coffee is disclosed in Patent No. 2,620,276 recently issued by the U. S. Patent Office. It consists of brewing the coffee within the sealed container in which it is to be sold to the consumer. The coffee is placed in the container, oxygen free water is added, oxygen present above the coffee is removed, the container is closed and then subjected to a sterilization process so that the coffee will retain its flavor and aroma indefinitely. Both whole roasted coffee beans and coffee concentrates can be used in the process. Licenses to use the processes covered by the patent will, according to the inventor, Dr. Wilbert A. Heyman, be made available to reputable firms throughout the world. Further information can be obtained from Dr. Heyman who is a widely known coffee chemist and president of the Heyman Process Corp., 29 Lewis St., New York City.

◆ ◆ ◆

Dodge & Olcott, Inc., sends in a beautifully done Flavor Brochure on Cosmo Flavors containing 28 pages of flavor formulas, charts, and suggestions for manufacturing and professional use. Also included are directions for preparing invert sugar syrups, soda fountain syrups, color solutions powdered flavors for ice cream, jelly and pudding mixes, and numerous other recommendations. Copies are available to flavor manufacturers for the food and confectionery industries on request to Dodge & Olcott, Inc., 180 Varick Street, New York 14, N. Y.

Also in this month's mail from the same firm is an attractive new Catalog of Essential Oils and Aromatic Chemicals. The catalog contains the latest prices and capsule information on essential oils, olearesins, resinexes, balsams, gums, animal fixatives, tinctures, aromatic chemicals, aromatic specialties, ionones, iraldeines, methyl ionones, vanilla aromatic chemicals, concentrated citrus oils, terpeneless oils. For a copy of this new D&O Catalog, write to the address given above.

◆ ◆ ◆

The Morton Salt Company, Chicago, announces a *free titration testing method booklet*, "Better Sauerkraut through effective use of salt," which is intended to serve as a working manual for the kraut industry. The booklet is waterproofed and rugged in construction to withstand use around the bench. End point colors, which need to be matched during the test, are accurately and handsomely reproduced and neatly protected by laminated plastic. The whole booklet is attractively bound and is perforated so that it may be hung up above a work table when used in the actual areas where kraut is produced. The booklet represents considerable research on the part of Morton Salt experts, both on the subject and its presentation. Kraut packers may obtain free copies by writing the National Kraut Packers Assn., 1020 North Blvd., Oak Park, Ill., or the Morton Salt Company, 120 So. LaSalle St., Chicago 3, Ill.

◆ ◆ ◆

E. I. duPont de Nemours and Company, Inc., announces a new high of $1,602,000,000 in total sales dur-

(Continued on page 24)

How Griffith's Extraction Process* Assures Better-Flavored Products

PEPPEROYAL AND SOLUBLIZED SEASONINGS

True Flavors in Smooth Mellow Blend —The Taste of Sunshine All the Time

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Food Industry Topics

(Continued from page 22)

ing 1952, but increased earnings of only six cents per share over 1951 owing to heavy federal taxes. Earnings were $4.70 per common share. The company spent $126 million during the year to build new plants and to expand or improve existing facilities, according to word from the company. Substantial expenditures were made on projects for "Dacron" polyester fiber, "Orlon" acrylic fiber staple, hydrogen peroxide, polyethylene, sodium cyanide, dynamite, tetraethyl lead, sulfuric acid, and cellulose sponges.

◆ ◆ ◆

A quickie from the Minute Maid Corporation announces the recent dedication of an attractive and efficiently designed *new research and development laboratory* at the company's Plymouth, Florida, plant—another contribution to the research progress of the food industries. The laboratory is to be known as the Norman J. Hayes Memorial Research and Development Building.

◆ ◆ ◆

Detecto Scales, Inc., Brooklyn, N. Y., announces several *new industrial scales*. New model "Detecto-Gram" Packing Scales permit many packing and mixing operations to be performed more speedily and accurately in industrial plants due to incorporation into these scales, for heavy-duty use, of modern over- and under-weight mechanism—hitherto confined to small scales. With this type of mechanism, the slightest deviation in required weight over or under is immediately indicated by the pointer moving off zero. In addition, any discrepancy in weight is made easily visible by having movement of pointer magnify the movement of the beam. These scales are available in the Detecto-Gram No. 8800 (bench model) and Detecto-Gram No. 8900 (floor model) and are recommended for weighing commodities such as flour, coffee, sugar, potatoes, chemicals. The company is also offering a highly rust-and corrosion-resistant brass scale for use wherever destructive actions of moisture, salt, lactic acid, and other acids are encountered as in the fish, dairy, and chemical industries. The scale, Model IC-474-05, has a three pound capacity and features a modern over-and-under dial mechanism for precision accuracy.

◆ ◆ ◆

Pioneer Pump, Division of Detroit Harvester Co., has added *three new centrifugal pumps and a new midget utility pump* to its line of over 400 models of standard centrifugal and positive displacement pumps. The new centrifugal pumps (models VBH, VD, and VE) are suitable for pumping practically all types of liquids not too viscous or too corrosive for modern corrosion resistant alloys, and, according to the manufacturer, offer ready adaptability to both intermittent and continuous pumping operations. Having no seals, pump bearings, or other moving metal-to-metal parts to wear, they are said to be particularly suited for handling liquids that are highly polluted with abrasives, chips, and other entrained solids. Each model is available in sizes from $\frac{1}{20}$ to 5 h.p., with several different port styles and mounting brackets. Larger sizes are rated up to 148 g.p.m. at free flow and 9 g.p.m. at 124.7 ft. of head (54 p.s.i.) based on water at 60° F.

The new Pioneer low-cost utility model "MU" midget centrifugal pump is designed to handle liquids where capacity requirements range from 0 to 6 gallons per minute from free flow to 6 feet of head. Design and performance characteristics make it readily adaptable to diversified applications such as liquid circulation in agitation tanks (of particular interest, perhaps, in the food field). Other uses are in laboratory work, commercial advertising displays, ornamental animated table and window displays, bird baths, small fountains, drink dispensers, water cooling units, aquariums, etc. Designed for continuous or intermittent operation, the pump can be supplied in a wide variety of materials including brass, stainless steel, and Monel metal.

◆ ◆ ◆

The Foxboro Company, Foxboro, Mass., manufacturers of indicating, recording, and controlling instruments, announces a *new Canadian plant* extension at Montreal which more than doubles the company's instrument manufacturing facilities in Canada. The company also sends in news of a new technical information sheet covering operation of Foxboro Model 40 Elapsed Time Controllers which automatically control the measured variable (temperature, pressure, etc.) at the desired value for a pre-set period of time. The type of control, says the company, has wide application in the food industries as well as in the textile, lumber and paper industries. Wherever process time is a factor this type of control is of vital importance. Designed for batch or repetitive processes, the instrument is described in its two major forms: controlling total "rise" and "hold" time, and controlling "hold" time only. Diagrams illustrate the standard operating cycles for each form of elapsed time control.

◆ ◆ ◆

Ten new organic chemicals, including purified natural pulegone, have been announced by the Eastman Organic Chemicals Department of Distillation Products Industries, division of the Eastman Kodak Company. The purified pulegone is a liquid of boiling point 95-98° F. at a pressure of 12 mm. and is present in such essential oils as oil of pennyroyal and oil of peppermint. It has a characteristic odor and flavor somewhat reminiscent of peppermint oil, and can be converted into other mint-flavored materials. The complete list of new Eastman Organic Chemicals is as follows: 3-Amino-1-proponal; 1,2,3,4-Butanetetracarboxylic Acid (Pract.); tert.-Butylhydroquinone (Pract.); m-(Chlorosulfonyl) benzoic Acid; N,N-Diethyl-1,3-propanediamine (Pract.); 6,7-Dihydroxynaphthalene-2-sulfonic Acid Sodium Salt; B-Dimethylamino-propionitrile; 2-Methoxyethyl Acetate; B-Methoxypropionitrile; Pulegone.

Eastman also discloses reduced prices for Eastman Isotope Concentrates of stable C^{13}. The price reductions apply to C^{13}—enriched barium carbonate, potassium cyanide, methyl alcohol, and methyl iodide. Hereafter they will be offered only in 60 to 70 atom percent excess C^{13}. The natural abundance of C^{13} is 1.1 atom percent. A non-radioactive isotope, C^{13} is used in tracer studies of human metabolism and in other research where radiation safety precautions are not feasible, the company states. The customary method of detection is mass spectography. The methyl alcohol and methyl iodide forms will be available only on special order, as before.

◆ ◆ ◆

Mr. Willard Huyck, president of the Aseptic-Thermo Indicator Co., Los Angeles, was recently a guest on the popular Al Jarvis Show, emanating from KECA-TV, Los Angeles. Colorful facts relating to the history of canning were brought out

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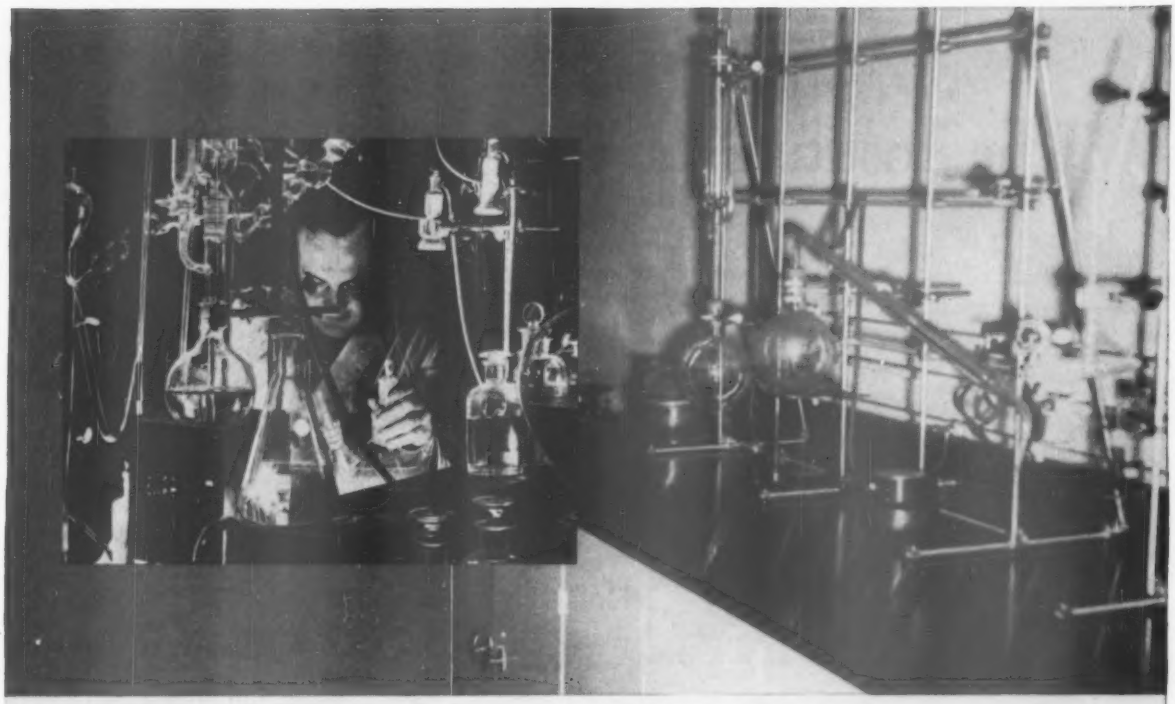

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Food Industry Topics

(Continued from page 24)

during the interview with emphasis placed on the high standards maintained by modern factory methods. The unique role of Cook-Chex, a scientific sterilization indicator was explained by

• The Cook-Chex checks the "cook" says Huyck to Jarvis.

Mr. Huyck. The color-change of Cook-Chex gives visual proof that time, temperature, and steam requirements have been met in the canning process.

◆ ◆ ◆

Estimates of production for 1955 and 1975 of *synthetic organic chemicals*, assembled from the five-volume report of the Materials Policy Commission (June 1952), are now available in booklet form from R. S. Aries & Associates, 400 Madison Ave., New York 17, N. Y. The material has been assembled into 18 tables which compare estimated production and use figures for many chemicals and chemical groups in 1955 and 1975 to actual production and use figures in 1950. Products include coal tar crudes, benzene, naphthalene, cyclic intermediates, cresols and cresylic acids, phenol, phthalic anhydride, styrene, cyclic end products, petrochemical crudes, ethylene, acetylene, methane, medicinals, plastics and resin materials, and synthetic fibers.

◆ ◆ ◆

American Bio-Chemical Laboratory, Inc., announces the election of Dr. S. L. Goldheim, an IFT member, as a vice president and director. Dr. Goldheim, who has been conducting research and development work in the chemical and fermentation industries for some years, will consolidate his own office and laboratory with that of ABC at 1612 Hartford Ave., Baltimore 13, Md. According to Mr. Eugene J. Gerberg, president, also an IFT member, this consolidation will permit the Laboratory to expand its field of endeavor while offering improved facilities in sanitation, filth analysis, and biological and chemical research. Mr. Robert Goren will continue as staff bacteriologist.

◆ ◆ ◆

Two members of the IFT were among the eight new members elected to The Forty Niners, service group of the Canning Machinery and Supplies Association, at the fourth annual meeting of the organization held in conjunction with the February National Canners' Conven-

(Continued on page 30)

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Food Industry Topics

(Continued from page 28)

tion in Chicago. The IFT members honored as new Forty Niners were: Mr. W. D. Lewis, Canning Machinery and Supplies Association, Battle Creek, Michigan; and Mr. Walter D. Pheteplace, The Pfaudler Co., Rochester, N. Y.

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The Refrigeration Research Foundation, Colorado Springs, Colorado, has initiated a new series of regional training conferences for the purpose of discussing technical problems in the freezing and storage of foods. To date, conferences have been held in the Missouri Valley, and on the west and east coasts. The Foundation will hold its Annual Meeting at the Shoreham Hotel, Washington, D. C., on May 15, 16, and 17.

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Among the U. S. Government Grants recently awarded for university lecturing and advanced research in foreign countries under the Fulbright Act is one in the field of food technology at the New South Wales University of Technology, Australia. The lectures are proposed to stress research rather than technological aspects and will center upon fundamentals of the processing of fruits and vegetables. The Fulbright Award program for 1954-1955 will be announced in June 1953 and will cover lectureships and/or advanced research awards in the following countries: Austria, Belgium and Luxembourg, Denmark, Egypt, Finland, France, Germany, Greece, Iraq, Italy, Japan, the Netherlands, Norway, Pakistan, Sweden, and the United Kingdom and Colonial Dependencies. For additional information write: Conference Board of Associated Research Councils, Committee on International Exchange of Persons, 2101 Constitution Ave., Washington 25, D. C.

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Conventions are always with us, and here is news from the Flavoring Extract Manufacturers' Association of the United States concerning their Forty-fourth Annual Convention to be held at the Hotel Traymore in Atlantic City on May 10 to 13, 1953. A diversified program has been planned featuring speakers from industry, governmental agencies, and educational institutions. Business and general sessions, question and answer periods, and an excellent entertainment program will round out the three-day meeting. Mr. Robert Krone, Fritzsche Brothers, Inc., New York City, is convention chairman.

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Still on the subject of conventions, a two-day Annual Production Conference was held in April at Lehigh University, Bethlehem, Pennsylvania, by the Pennsylvania Manufacturing Confectioners' Association. Principal addresses were presented by Dr. H. A. Neville, director, Institute of Research, Lehigh University, and Mr. Philip P. Gott, president, National Confectioners' Association. An interesting feature of the meetings was a panel discussion of the relative merits of Swiss and American chocolates.

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From Continental Can Co., Inc., New York City, comes news of the election of Mr. Benjamin C. Betner, Jr., as a vice president. According to Gen. Lucius D. Clay, board chairman, Mr. Betner who was formerly

(Continued on page 32)

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Write to Technical Director, Diamond Crystal Salt Co., St. Clair, Michigan.

DIAMOND CRYSTAL SALT with Antioxidant

Food Industry Topics

(Continued from page 30)

president of the Benjamin C. Betner Company will be in charge of Continental's new Betner Division which will operate as a separate unit, manufacturing small and medium sized bags from such materials as paper, foils, cellophane, glassine, plastics, and wax paper.

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A very attractive illustrated brochure arrived in the mail from Kansas State College, Manhattan, Kansas. Entitled "Prepare for a Career in Milling at Kansas State College," the brochure furnishes information on training opportunities for careers in the flour and feed industries offered high school graduates at that educational institution.

◆ ◆ ◆

Word has been received that American Can Company is now releasing "The Miracle of the Can," a 41-minute color motion picture story of the packaging revolution in America during the past half century. The 16-mm. film tells a dramatic and entertaining story of the contribution made by the can-making and can-using industries to the American way of life and to America's victory in the age-old battle against hunger by opening up vast new markets for the products of American farms, factories, and fisheries. The movie also goes behind the scenes to show the evolution of tin cans from the days of manual production to today's high speed production line. "The Miracle of the Can," professionally produced and acted, is available for showing to business, civic, scholastic, industrial, and agricultural groups throughout the country.

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At the annual meeting of the board of directors of The Givaudan Corporation, Mr. E. R. Durrer was elected president of the company and its affiliates—Givaudan-Delawanna, Inc., Givaudan Flavors, Inc., Sindar Corporation, and Givaudan-Foreign, Inc. Mr. Durrer succeeds Dr. Eric C. Kunz who had retired from active management of the firm in 1947 when Mr. Durrer assumed the executive management as executive vice president. Other officers elected were: Mr. F. N. Bangs, vice president and secretary; Mr. H. F. Duffy, treasurer; Dr. Max Luthy, vice president in charge of production and research; and Mr. R. E. Horsey, vice president in charge of sales. Mr. Hans Kessler continues as sales manager of Givaudan Flavors, Inc.

◆ ◆ ◆

The tools of the modern analytical chemist, developed to solve the many complicated problems in research, development, and production, were discussed and illustrated by Dr. George L. Royer, director Analytical Chemistry, Calco Chemical Division, American Cyanamid Company, in his address, "Research Frontiers: Modern Analytical Chemistry," presented at the 1953 Student Award Meeting of the New York Chapter of the American Institute of Chemists held March 26, 1953. The student A. I. C. awards are a yearly feature of the New York Chapter's program, in which outstanding chemistry students in the New York district are honored with dinner and an appropriate presentation.

(Continued on page 34)

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Food Industry Topics

(Continued from page 32)

The successful man in industry earns four times as much as the successful government executive, Jerome M. Rosow, former director of the policy division of the Office of Salary Stabilization, reported in the March issue of *Personnel*, published by the American Management Association. Only 300 federal officials, according to Rosow, earn more than $15,000 a year, which is "almost an entrance salary for industry executives." Data collected by the SEC show that in nine of the reporting industries with the lowest salary levels the range of average compensation for top corporate executives (the three highest paid executives of each company) is between $12,000 and $20,000. In industries with high compensation patterns these averages range between $50,000 and $80,000 yearly. Maximum annual salary for the highest paid federal executives, cabinet officers, is $25,000. The problem of the career government worker is further intensified by inflation, reports the *Personnel* article. Since 1939, average weekly earnings of manufacturing employees have increased 180 percent. In contrast, the maximum salary for the highest federal career grade has advanced 31 percent compared with a 92 percent increase in living costs. In addition to the marked differences in direct compensation, the government executive is far outclassed by the industrial executive in auxiliary benefits and non-financial incentives, according to Rosow. Expense accounts and personal requiset for industrial executives further widen the gap.

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Nine specific recommendations for research on peanuts were adopted at the peanut conference on utilization for edible purposes, held in New Orleans, February 5-6, 1953, at the Southern Regional Research Laboratory of the USDA Bureau of Agricultural and Industrial Chemistry. Improvement in quality of raw material was stressed repeatedly as the most important problem confronting the different segments of the industry. Adopted at the conference was a resolution that the various peanut trade associations appoint committees to confer with the Southern Laboratory and with other agencies conducting research on peanuts.

◆ ◆ ◆

And so, back goes the cover on the "topical" typewriter until the postman rings again.

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FIRST MEETING OF THE AGRICULTURAL RESEARCH INSTITUTE, OCTOBER 16, 1952

The first meeting of the newly organized Agricultural Research Institute was held at the National Academy of Sciences in Washington, October 16, 1952.

Attendance of approximately 100 industrial, governmental, and academic scientists included members of the Agricultural Research Institute and the Agricultural Board of the National Research Council.

Officers and a Board of Governors were elected for the Agricultural Research Institute (see list) and proposed by-laws for the ARI, after thorough discussion, were approved pending some clarification of wording.

Dr. W. E. Krauss, Chairman of the Agricultural Board, reviewed the current activities of the Board as a background for further development of activities in conjunction with the ARI. Chairmen of Committees on Animal Nutrition, Animal Health, Feed Composition, Maize Preservation, and Plant Ecology presented reports.

Many new fields of activity were proposed and discussed by the Agricultural Board, which met October 17th to reorient its program in view of the stimulating discussion and enthusiasm for the future of agriculture developed at the October 16th meeting.

Officers of the ARI are: President, Roy C. Newton, Swift and Company; Vice President, Paul D. V. Manning, International Minerals & Chem. Corp.; Secretary, B. S. Clark, American Can Company. Members of the Governing Board are: Victor Conquest, Armour and Company; Norman F. Kennedy, Corn Industries Research Foundation; J. R. Holbert, Funk Bros. Seed Company; R. P. Dinsmore, Goodyear Tire & Rubber Company; C. L. Rumberger, H. J. Heinz Company; R. R. Poynor, International Harvester Company; John Knowles, Libby, McNeill & Libby; C. C. Weigand, Eli Lilly and Company; Oliver DeGarmo, Monsanto Chemical Company; Claude L. Welch, National Cotton Council; Alexander Frieden, Pabst Brewing Company; H. E. O. Heineman, Pet Milk Company; Walter Blake, Pillsbury Mills, Inc.; R. M. Bethke, Ralston Purina Company; E. W. Adams, Standard Oil Company (Indiana); A. A. Nikitin, Tennessee Corporation; Howard C. Spencer, Dow Chemical Company.

Institutional members of the Board are: B. T. Shaw, Agricultural Research Administration; H. H. Plough, American Genetic Association; K. S. Quisenberry, American Society of Agronomy; E. P. Johnson, American Veterinary Medical Association; A. A. Spielman, Connecticut Agricultural Experiment Station; N. J. Volk, Indiana Agricultural Experiment Station; C. B. Hutchison, Nevada Agricultural Experiment Station; J. H. Jensen, North Carolina Agricultural Experiment Station; G. F. Geissler, Production and Marketing Administration; E. L. Demmon, Society of American Foresters.

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There is very little production of frozen fillets in Mexico. Some species, such as Gulf pike and sea bass, are frozen in fillet form on a limited scale by several freezing plants located in Guaymas and Mazatlan. Some of this production is exported, but the greater part is sent to Mexico City and other centers of domestic consumption.

The products canned are, in order of their importance: California sardine, Pacific mackerel, abalone, tuna, Spanish mackerel, shrimp, oysters, and mullet. A variety of other species are packed to a lesser degree, but their importance in the total pack is minor.

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in No. 2 cans and in oval one-pound cans and is put up both in tomato sauce and brine. The Pacific mackerel and abalone are packed in brine. Canned tuna has a little oil added, while most other products are packed in their natural form with the addition of a little salt.

The canning and freezing plants, small and large, represent an estimated total investment of $10 million.

Dry fish is a fairly important item in Mexico, but the amount of smoked and kippered fish produced in Mexico, is insignificant. [From Fisheries Leaflet 339, *Com. Fisheries Review*, **13** (7) 86 (1951).]

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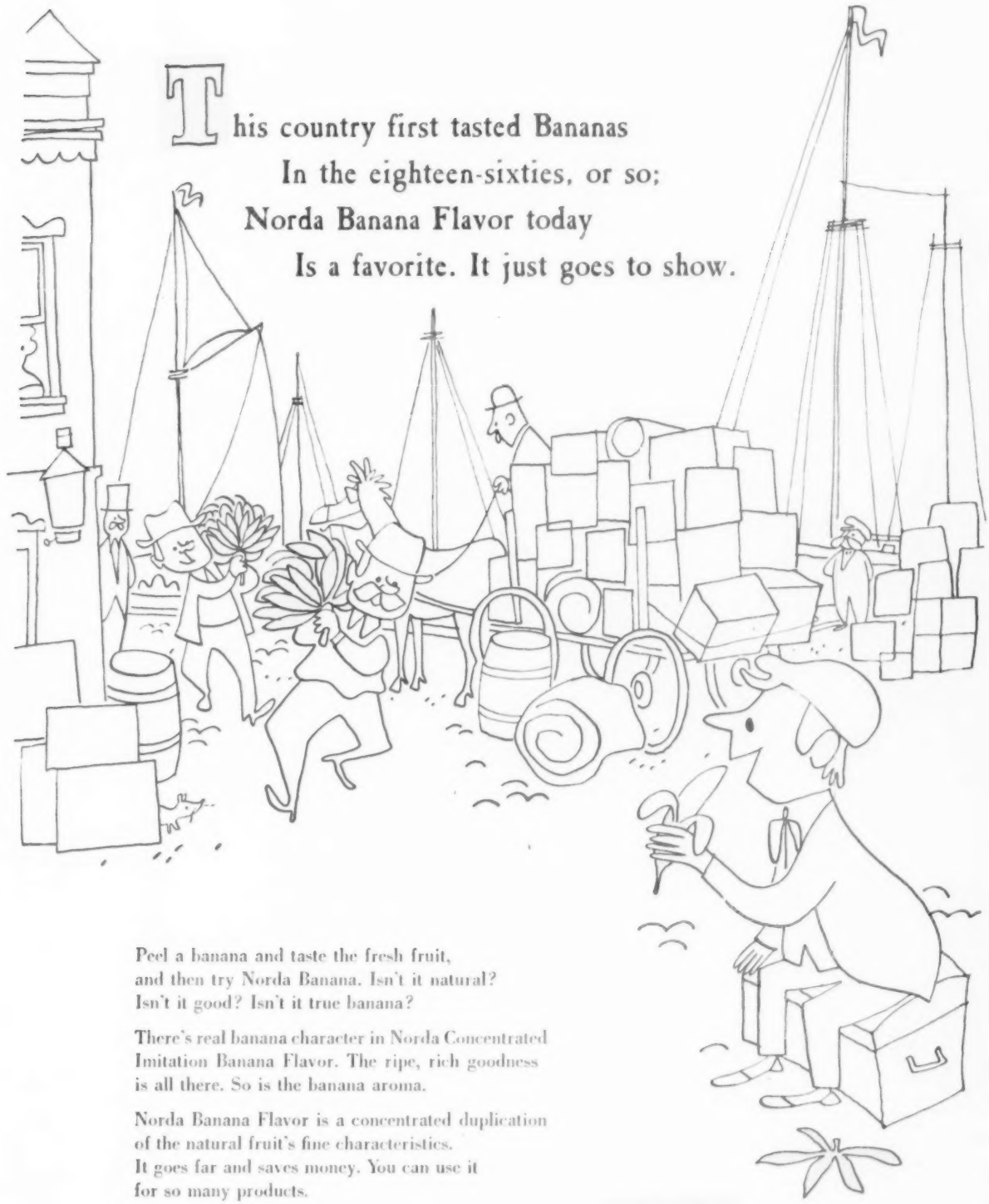

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NOTE: Full technical report published in November 1952 FOOD TECHNOLOGY Magazine "The Use of Monosodium Glutamate in Frozen Foods" by Carl B. Norton, Donald K. Tressler, and Lillian D. Farkas.

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